Pegram Highway 70 Flood Remediation

Final Design Academic Report

April 2017

Highway 70 Shopping Area
500 Block Hwy 70
Pegram, TN 37143

Enclosures:

A) Request for Proposal
B) Proposal
C) Concept Plan & Historical Review
D) Existing Conditions Package
E) Design Development Package
F) Man-Hour Log & Timesheets
G) Meeting Minutes
H) Presentation Slides
I) Reference Material

Contributors:
Nathan Curtis
David Lowery
Cody Glenn
Abigail Queen
Christian Reid

Section 1: Background Information

The city of Pegram, TN sent a request to the Civil Engineering Department at Lipscomb University for the provision of engineering services to assist with flooding issues at the 500 block of Highway 70, Pegram TN. Flooding at this location occurs multiple times a year, typically incurring property damage. Because the flood area is commercial, business is disrupted and often drives business owners away. It is also reported that the flooding will overtop Highway 70 in a large storm, creating safety issues.

Section 2: Design Team

The members of the design team and their respective roles are as follows:

Student Design Team

- **David Lowery- *Project Manager***
  - Has gained project management experience through working as a *Project Management Intern* on two multi-million-dollar construction projects for Brasfield & Gorrie General Contractors.
  - Has gained site design & storm-water management experience, as well as survey experience through an internship in the Land Planning Division with Gresham Smith & Partners.
- **Abby Queen –*Assistant Project Manager***
  - Has gained project management experience through working as a *Project Engineer* for Meccon Industries Inc.
  - Has exceptional writing & communication skills.
- **Nathan Curtis – *Lead CAD Drafter / Lead Survey Manager***
  - Has gained CAD drafting experience through working as an *AutoCAD Drafter* for Malo Studios, as well as through working as an intern for Engineering Missions International.
  - Has gained survey experience through completing the Surveying course within Lipscomb University's Engineering Program.
- **Cody Glenn – *Lead Estimator***
  - Has gained significant experience in estimating through his internship with Jones Brothers Contractors.
- **Christian Reid – *Hydraulic Analysis & Design Lead***
  - Has gained experience in hydraulic analysis & design through his Fluid Mechanics & Hydrology courses at Lipscomb.
  - Has gained experience in hydraulic analysis through his position as an *Environmental Engineering Intern* with General Mills Inc.

Technical Advisors

- Chris Gwaltney P.E.
- Matt Lackey, P.E.
- Justin Bryan, P.E.
- Peter Chimera, E.I.T.

Section 3: Scope of Services

The scope of this project was to provide analysis, and design for the purpose of proving that the existing conditions cause the culverts under HWY 70 to fail per TDOT standards, and to provide design development drawings to aid in future design and construction of a flood control plan.

Deliverables:

- Concept Plan & Historical Review:
  - This included a historical review, decision matrix, and a recommended flood control plan.
- Complete set of design development construction drawings submitted at:
  - 30%, 60%, 90%, and Completed Design Development.
  - Each submittal included a design report with a preliminary construction cost estimate.
- A Final Report, including:
  - Oral Presentation to client
  - Oral Presentation to Lipscomb Engineering Dept.
  - Oral Presentation at Symposium
  - Poster Presentation at Symposium

Section 4: Project Summary

To meet the requested scope of services, the team proposed the following phasing plan to complete the work.

- **Phase 1 – Site Investigation**
- **Phase 2 – Survey**
- **Phase 3 – Preliminary Analysis & Design**
- **Phase 4 – Final Design**

Phase 1 – Site Investigation

The purpose of this task was to gather site data and information for future design work. Subtasks during Phase 1 included:

- Site Visits
  - The team Performed an initial site visit to meet with the mayor and take pictures of the site. The mayor showed us each problem area and pictures were taken for reference during the design phase. Pictures can be found in *Enclosure I.*
- Researching TDOT Culvert Requirements
  - Research was conducted to obtain the TDOT standards for culverts in order to make a comparison between the performance of existing culverts, and the performance standards set out by TDOT. The standards can be found summarized in *Enclosure D*, as well as in the TDOT drainage manual found in *Enclosure I.* After analysis, it was found that all the culverts along the flow path of interest are failing per TDOT standards. The detailed results can be found in *Enclosure D.*
- Research Historical Flood Data
  - A well-developed storm history was developed using NOAA public information. This data was used to create a Historical Review of Flooding for the town of Pegram. This review can be found in *Enclosure C.*

Phase 2- Survey

The purpose of this task was to gather data that would be used to create a topographic map. This topo map would become the basis for preliminary and final design solutions.

The subtasks during the survey phase included:

- Delineating the Survey Boundary
  - Using Google maps, a general survey boundary was created to ensure sufficient survey data is collected.
- Present Project to Survey Team
  - A presentation was made to inform the survey team of the survey boundary, scope of the survey, and other logistical information.
- Preliminary Survey
  - The design team performed a preliminary survey at the site to find benchmarks and set control points for the survey team. Because no existing benchmarks could be found, a benchmark was assumed at the corner of Hwy 70 and Dogwood Ln and was given a known elevation

of 0ft. The location of this benchmark is shown in the design development drawings in *Enclosure E.*

- Provide Oversight to Survey Team
    - The survey was conducted by the sophomore survey class under the oversight of the design team. The survey was conducted using 3 Topcon total stations, and the following data was included:
        - Topographic data
        - Culvert locations and inverts
        - Edge of Pavement
        - Ditch locations and elevations
        - Building locations
- Produce Topographic Map / Site Plan
    - The survey data was transferred into AutoCAD Civil 3d and was delineated into a topographic site survey. The survey can be found in *Enclosure D.*

Phase 3- Preliminary Analysis & Design

The purpose of this task was to determine possible design solutions so that the team could make a recommendation to the City of Pegram for a proposed solution and receive feedback from the city.

. Subtasks during Phase 3 included:

- Delineating Drainage Basin
    - Using USGS Topo Maps, a drainage basin was delineated by using contour lines and known knowledge of the site from site visits. It was found that the drainage basin for the culverts at Hwy 70 was approximately 150 acres. The watershed map can be found in *Enclosure D.*
- Hydraulic Analysis
    - The survey and drainage basin data was used to perform a hydraulic analysis of the watershed, specifically along the flowpath of interest. It was determined that there are 3 different drainage basins contributing to the flows at the Culverts at the 500 block of Tennessee Highway 70, our primary area of interest. The largest drainage basin is approximately 100 acres northwest of the site, next is approximately 20 acres northeast of the primary site, and finally the 30 acre residential around the houses just north of the primary site. Once the drainage basins were delineated, the TR-55 method was

used to determine time of concentration and then that data was used as an input for Hydroflow, an Autodesk extension commonly used in practice, to determine our flows at the primary site. This information was then used to analyze our culverts throughout the project area.

- Culvert Analysis
  - Hydraulic capacity of the current culverts was evaluated using Hydroflow Express within the AutoCad Civil 3d Suite. The culverts were analyzed using the flows found from the hydraulic analysis. Hydroflow Express used the manning's equations to solve for the flows in the culverts, and took into account pipe roughness, size, length, slope, and other factors. It was found that when modeled for the 50yr storm, each culvert along the flow path of interest was failing with flows overtopping the road. The details of the culvert analysis can be seen in *Enclosure D – Existing Conditions Package*

- Preliminary Design
  - The preliminary design consisted of exploring possible solutions to the problems found while performing the hydraulic analysis. A concept plan was created outlining the possible solutions that would be further explored in the Final Design phase. This concept plan can be found in *Enclosure C.*

- Create Decision Matrix
  - The decision matrix was used to determine the best solution for the City of Pegram. The criteria for the decision matrix were weighted usings a paired comparison analysis. The 5 criteria (Cost, Aesthetics, Performance, Maintenance and Land Use, and Durability) were matched against each other and given weight proportional to their importance. IE: When Aesthetics [B] is compared to cost [a], cost is given the more importance by a factor of 3, thus the cell is given the name A3. The final weight was determined by taking the total number each criterion is given over the total number added after all comparisons have been made. These weights were then used as a multiplier in the decision matrix, which compared the 3 preliminary designs (detention basin, water reroute and culvert modification) with each design's criteria rank.

Phase 4 – Final Design

The purpose of this phase was to fully design the method, or combinations of methods chosen by the Design Team in conjuncture with the City, and to produce complete design development drawings and specifications to present to the City of Pegram.

Detention Pond Design:

Detention ponds were developed to control release rate of the large amount of water flowing to the culverts at Tennessee Highway 70. This flow was largely due to a contributing watershed of approximately 100acres located north of the site. It was found in the hydrologic analysis that this flow would need to be slowed to meet the requirement established by TDOT for culverts (that they must pass the 50yr storm). The pond was developed using Hydroflow, which is an extension of Autodesk's Civil3D program. The program allowed the team to determine the approximate size requirements of detention and the appropriate release rate. Using the size and release rate information found in Hydroflow, the pond size was then iterated using a 3:1 side slope until the desired capacity was reached. The Hydroflow extension also allowed us to specify a proper outlet structure that would give the desired release rate. The details of the pond design can be found in *Enclosure E – Design Development Package.*

Diversion Design:

A diversion ditch was designed to help decrease the flow of water to Highway 70. In preliminary analysis, it was noted that there seemed to be a ditch that travelled away from the primary flow path, along the back of the businesses toward Dogwood Lane. The observed ditch did not intersect with the primary flowpath, and therefore the ditch was not being effectively utilized. The Pegram Design team developed a concrete channel that extends the ditch and intersects with the primary flow path. This allows for the flow to be directed away from highway 70. In addition to a channel, a detention structure has been added to control the amount of water that is diverted. This structure allows for a small amount of water to pass through to highway 70, and once the flow reaches the maximum flowrate that Hwy 70 can handle, any additional flow is diverted along the diversion channel, away from Hwy 70. Details for the diversion design can be seen in *Enclosure E – Design Development Package*.

Construction Cost Estimates:

The purpose of this task was to estimate the cost of construction for the proposed solutions. There were 2 major parts of the estimate: detention and diversion.

- Detention: For the detention pond, the scope included in the estimate is grading, reseeding, replacing topsoil, fill material for the dam, and a construction entrance. The fill material is to have a clay content equal to 15-30% by weight and less than 10% coarse aggregates. For the pond, all cut material is used onsite for fill, therefore saving money by not having to haul the cut away.
- Diversion: The diversion ditch estimate for the concrete channel and diversion structure includes the following scope: cut, haul off, formwork, resteel, concrete placement, and backfill.

The construction cost estimates were derived from unit prices provided by the lead estimator at Jones Bros Contractors LLC. The cost estimate breakdown can be seen in *Enclosure E – Design Development Package*.

Section 5: Quality Assurance / Project Management

The quality of the design work provided was monitored by the project manager and by all members of the design team in the following ways:

- Action Items
  - An action items spreadsheet was maintained by the project manager through the duration of the project so that all team members knew what tasks they are responsible for.
- Weekly Timesheets
  - All hours worked by each team member were logged on a weekly timesheet and sent to the Assistant Project Manager each Friday.
- Weekly Progress Meetings
  - The team held a weekly meeting to monitor the quality and progress of the work which each respective team member was responsible for.
- Technical Advisor Meetings
  - The team held meetings with technical advisors at milestone checkpoints throughout the duration of the project.

RAYMOND B. JONES
COLLEGE OF ENGINEERING

Enclosure (A):

Request for Proposal

REQUEST FOR PROPOSAL (RFP)

PEGRAM, TN FLOOD REMEDIATION

AUGUST 30, 2016

RAYMOND B JONES COLLEGE OF ENGINEERING
LIPSCOMB UNIVERSITY
1 UNIVERSITY PARK DRIVE
NASHVILLE, TN 37214

TABLE OF CONTENTS

1. Summary and Background

Lipscomb University's Raymond B Jones College of Engineering in partnership with the town of Pegram, TN is currently accepting proposals for the design of flood control structures in Pegram, TN. Currently the town of Pegram experiences frequent flooding of US Highway 70 and commercial properties along US 70. The flooding hampers economic development for the town, causes delays for emergency vehicles, and is a safety concern for travelers on US 70.

The purpose of this Request for Proposal (RFP) is to solicit proposals from various student teams, conduct a fair and extensive evaluation based on criteria listed herein, and select the candidate who best represents the direction Raymond B Jones College of Engineering wishes to go.

Raymond B Jones College of Engineering is an academic unit under the auspices of Lipscomb University for the education and training of engineers in three ABET/EAC accredited engineering programs: Civil Engineering, Electrical and Computer Engineering, and Mechanical Engineering. The college of engineering at Lipscomb focuses primarily on undergraduate engineering education within a faith-based community. Our client base consists of small and medium-sized businesses as well as international non-governmental humanitarian organizations which lack engineering experience and expertise.

Raymond B Jones College of Engineering is located in Nashville, Tennessee on the campus of Lipscomb University.

Our services include:
- Engineering Design
- Engineering Studies

Customer contacts
Executive Manager: Charles Moorehead, Pegram Mayor and Sean Monahan, US EPA
Project Executive: Chris A. Gwaltney

2. Proposal Guidelines

This Request for Proposal represents the requirements for the proposal process as part of the graduation requirements for engineering students in the Raymond B Jones College of Engineering. Proposals will be accepted until 8:00 am CST November 1, 2016. Any proposals received after this date and time will be returned to the sender. All proposals must be signed by the proposed project manager and all team members.

If the team submitting a proposal must outsource or contract any work to meet the requirements contained herein, this must be clearly stated in the proposal. Additionally, all costs included in proposals must be all-inclusive to include any outsourced or contracted work. Any proposals which call for outsourcing or contracting work must include a name and description of the organizations being contracted.

All costs must be itemized to include an explanation of all fees and costs.

Contract terms and conditions will be negotiated upon selection of the highest qualified firm for this RFP. All contractual terms and conditions will be subject to review by Raymond B Jones College of Engineering and will include scope, budget, schedule, and other necessary items pertaining to the project.

3. Project Purpose and Description

The purpose of this project is as follows:
To provide design documents, including plan drawings and specifications to facilitate the construction of flood control structures to alleviate flooding in Pegram, TN.

Project Description:
Pegram, TN is located approximately 23 miles west of Nashville along US Highway 70 (see figure 1). Flooding in Pegram is a result of storm water runoff from highlands to the north of town. The runoff drains to the south towards the Harpeth River, but must first pass under US 70 and a CSX rail line (see figure 2). The culverts under US 70 are inadequate to pass the runoff of relatively frequent rainfall events and thus water backs up into the commercial area along the highway, and eventually overtops the highway. The flood water is then retained by the CSX railroad embankment until it can drain through a culvert and bridge under the railroad. The rainfall return frequency for the flood events is unknown to the RFP writer. This project is part of the The College/Underserved Community Partnership Program (CUPP) through the US EPA.

https://www.epa.gov/communityhealth/collegeunderserved-community-partnership-program-cupp

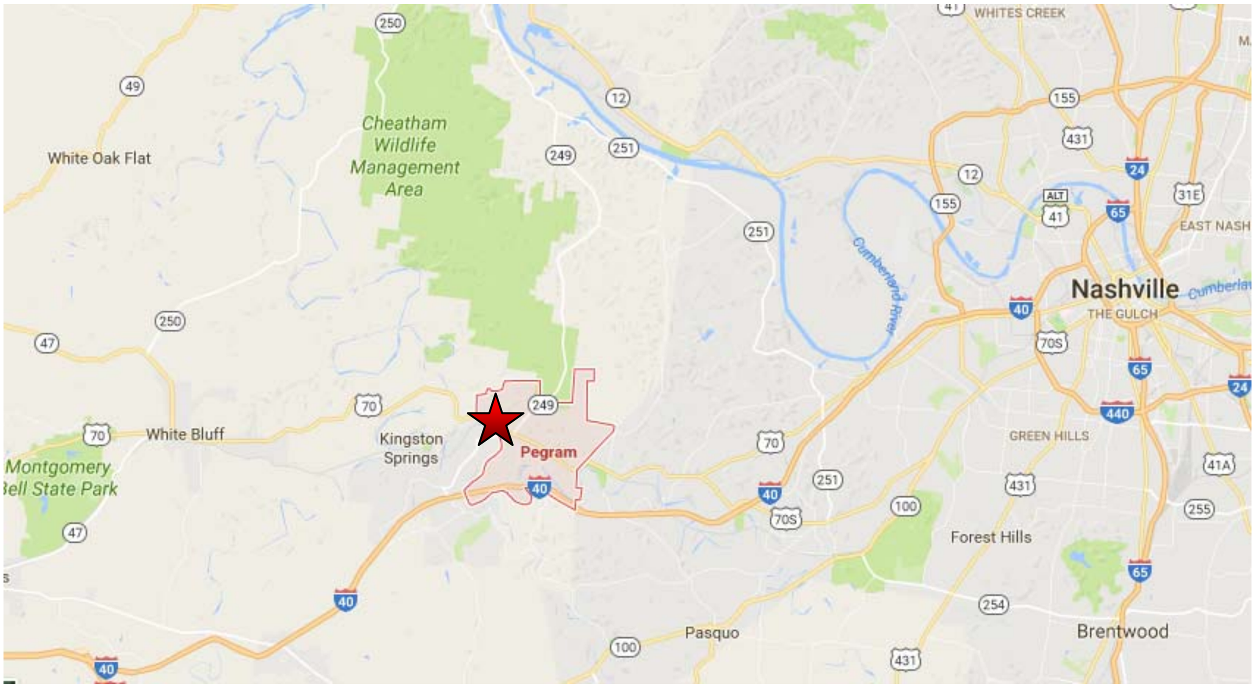

Figure 1. Site Location

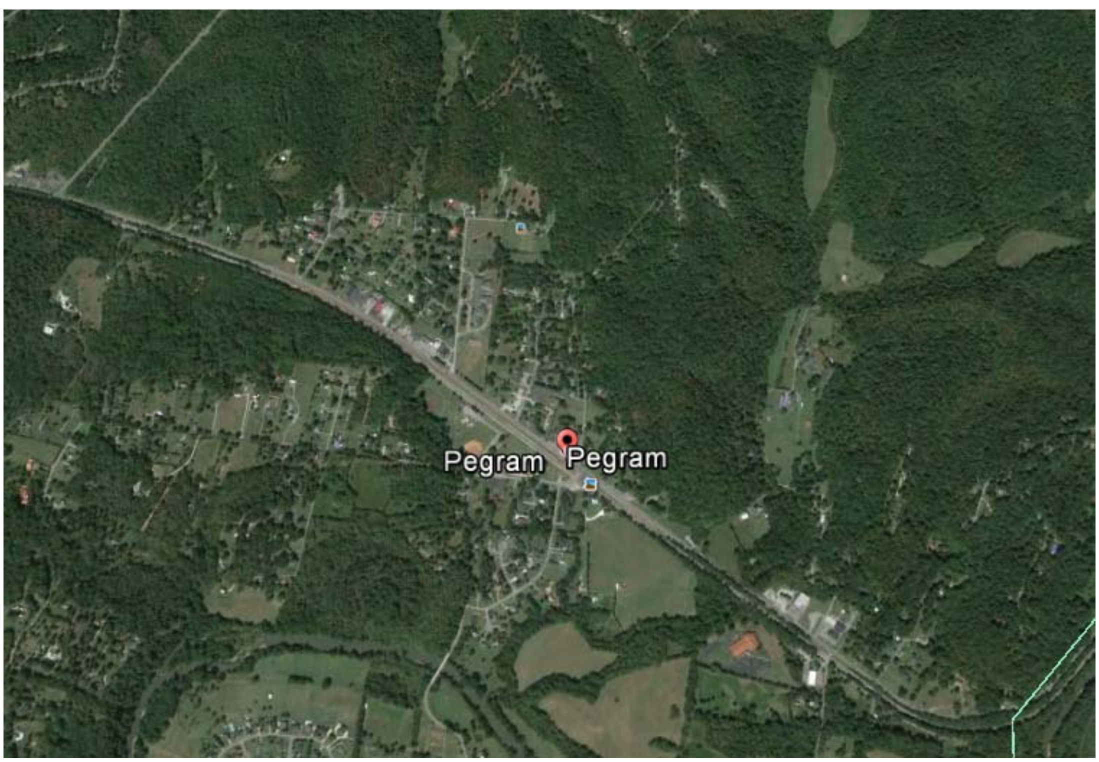

Figure 2. Pegram, TN Aerial

Figure 3. Commercial Area

4. PROJECT SCOPE

The scope of this project is to provide all analyses, laboratory testing, design, and construction documentation required for the design and construction of a comprehensive flood control project for Pegram, TN.

The following criteria must be met to achieve a successful project:

- Historical review of flood events in Pegram.
- Historical review of any flood studies performed for Pegram.
- A topographic survey of the primary areas flooded in Pegram.
- Determine possible flood control practices, structures, and combinations of such that will relieve flooding in Pegram; including their advantages, disadvantages, costs, and constraints.
- Development and implementation of a decision matrix for selection of a flood control plan to carry out for the final design.
- Work with the town officials in Pegram, the Tennessee Department of Transportation (TDOT), CSX Railroad, and The College/Underserved Community Partnership Program (CUPP) through the US EPA.
- A hydrologic/hydraulic study required for the design.
- Final design for all components of the selected flood control plan.

Deliverables

- Feasibility Report (with historic review, presentation of completed decision matrix, and a recommended flood control plan). This report will be presented at a review meeting with the client and other interested parties.
- Complete set of construction drawings submitted at:
  - 30%, 60%, 90%, IFC.
  - Each submittal shall include a design report with a preliminary construction cost estimate.
  - Specifications shall be provided with each submittal, except the 30% submittal.
  - An invoice for work completed will be provided at each submittal
- A Final Report, including:
  - Sections on all parts of the design
  - Oral Presentation to client
  - Oral Presentation at Symposium
  - Poster Presentation at Symposium

5. Request for Proposal and Project Timeline

Request for Proposal Timeline:
All proposals in response to this RFP are due no later than 8:00 am CST November 1, 2016.

Presentation of the Proposal to the client shall be on November 8, 2016. Evaluation and negotiations of the proposal will be conducted immediately following the presentation. The Final Proposal will be signed and the Notice to Proceed (NTP) issued no later than end of business on November 9, 2016.

Project Timeline:
Project work begins immediately upon receipt of the NTP.

Date due	Deliverable
December 6, 2016	Site Survey
December 6, 2016	Historic Review, Conceptual Flood Control Plans, & Decision Matrix with criteria and weighting
January 24, 2017	Completed Decision Matrix with selected plan & 30% Submittal
February 14, 2017	60% Submittal
March 7, 2017	90% Submittal
March 28, 2017	Final Design Report and PowerPoint slides for Oral Presentation
April 4, 2017	Oral Presentation
April 11, 2017	IFC Drawings and Specifications

6. Budget and Schedule

All proposals must include a detailed schedule linked to a valid Work Breakdown Structure (WBS) identifying each task necessary for successful completion of the project. Person-hours associated with each task must be clearly tabulated along with each task's duration.

In addition to the detailed breakdown, a summary accounting of man-hours and direct costs to complete the tasks described in the project scope must be listed for each of the following items in accordance with the format below:

Task	Person Hours
Historic Review, Conceptual Plan, & Decision Matrix with preferred plan	xxx
Hydrologic/Hydraulic Study	xxx
Design of Flood Control Structure(s)	xxx
Meetings with client and other parties	xxx
Final Design Report and Oral Presentation	xxx
CAD	xxx
Specifications	xxx

Direct costs will be provided for all items required to complete the work.

A fee schedule will be provided for all labor anticipated to complete the work.

7. Team Qualifications

Teams must provide the following items as part of their proposal for consideration:

- Description of experience.
- Resumes of all team members
- Management plan detailing areas of responsibility for each team member.
- Timeframe for completion of the project

8. Quality Assurance

Each team will provide a detailed plan to assure that a high quality product is delivered.

9. Proposal Evaluation Criteria

Raymond B Jones College of Engineering will evaluate all proposals based on the following criteria. To ensure consideration for this Request for Proposal, your proposal should be complete and include all of the following criteria:

- Overall quality of the response to this Request for Proposal.
- Overall proposal suitability: proposed solution(s) must meet the scope and needs included herein and be presented in a clear and organized manner
- Value and Quality: Teams will be evaluated on the value and quality their solution(s) based on the work to be performed in accordance with the scope of this project
- Technical expertise and experience: Teams must provide descriptions and documentation of staff technical expertise and experience

Each team must submit 2 copies of their proposal to the address below by November 11, 2016 at 8am CST:

Raymond B Jones College of Engineering
Lipscomb University
1 University Park Dr
Nashville, TN 37214

LIPSCOMB UNIVERSITY | RAYMOND B. JONES COLLEGE OF ENGINEERING

Enclosure (B):

Project Proposal

Charles Moorehead
Mayor, City of Pegram
Pegram City Hall
308 Highway 70
Pegram, TN 37143

Dear Mr. Moorehead,

Subject: Proposal for Engineering Services – Flood Remediation
Highway 70 Shopping Area
Pegram, TN 37143

Enclosures:

(A) Proposal for Engineering Services
(B) Preliminary Work Breakdown Structure
(C) Estimated Project Schedule

Lipscomb University Senior Design Team presents for the town of Pegram our proposal for engineering services to remediate the flooding issue at the 500 block on Tennessee Highway 70. We have prepared this proposal based on the following information.

- Request for proposal submitted to the group by Lipscomb University as a basis for the senior design project
- Site Visit & Meeting with Mayor of Pegram
- Aerial photography of the site
- Publically available historical data

The Lipscomb University Senior Design Team appreciates the consideration of the City of Pegram for our participation on the project.

Sincerely,

- David A. Lowery

Enclosure (A):

Proposal for Engineering Services

Section 1: Background Information

The city of Pegram, TN sent a request to the Civil Engineering Department at Lipscomb University provide engineering services to assist with flooding issues at the 500 block of Highway 70, Pegram TN. Flooding at this location occurs multiple times a year, typically incurring property damage. Because the flood area is commercial, business is disrupted and often drives business owners away. It is also reported that the flooding will overtop Highway 70 in a large storm, therefore creating safety issues. This proposal, based upon the request for proposal, historical data, site visits, and conversations with longtime Pegram residents, is a proposal for engineering services to analyze the flooding problem, and design a solution.

Section 2: Design Team

The members of the design team and their respective roles are as follows:

Student Design Team

- **David Lowery- *Project Manager***
  - Has gained project management experience through working as a *Project Management Intern* on two multi-million-dollar construction projects for Brasfield & Gorrie General Contractors.
  - Has gained site design & storm-water management experience, as well as survey experience through an internship in the Land Planning Division with Gresham Smith & Partners.
- **Abby Queen –*Assistant Project Manager***
  - Has gained project management experience through working as a *Project Engineer* for Meccon Industries Inc.
  - Has exceptional writing & communication skills.
- **Nathan Curtis – *Lead CAD Drafter / Lead Survey Manager***
  - Has gained CAD drafting experience through working as an *AutoCAD Drafter* for Malo Studios, as well as through working as an intern for Engineering Missions International.
  - Has gained survey experience through completing the Surveying course within Lipscomb University's Engineering Program.
- **Cody Glenn – *Lead Estimator***
  - Has gained significant experience in estimating through his internship with Jones Brothers Contractors.

- **Christian Reid – *Hydraulic Analysis & Design Lead***
    - Has gained experience in hydraulic analysis & design through his Fluid Mechanics & Hydrology courses at Lipscomb.
    - Has gained experience in hydraulic analysis through his position as an *Environmental Engineering Intern* with General Mills Inc.

Technical Advisors

- Chris Gwaltney P.E.
- Matt Lackey, P.E.
- Justin Bryan, P.E.
- Peter Chimera, E.I.T.

Section 3: Scope of Services

The scope of this project is to provide analysis, design, and construction documentation required for the design and construction of a flood control plan for Pegram, TN.

- Historical review of flood events in Pegram.
- Historical review of any flood studies performed for Pegram.
- A topographic survey of the primary areas flooded in Pegram (subcontracted to Lipscomb surveying course, but administered by team).
- Determine possible flood control practices, structures, and combinations of such that will relieve flooding in Pegram; including their advantages, disadvantages, costs, and constraints.
- Development and implementation of a decision matrix for selection of a flood control plan to carry out for the final design.
- Work with the town officials in Pegram, the Tennessee Department of Transportation (TDOT), CSX Railroad, and The College/Underserved Community Partnership Program (CUPP) through the US EPA.
- A hydrologic/hydraulic study required for the design.
- Final design for all components of the selected flood control plan.

Deliverables:

- Feasibility Report
    - This will include a historical review, presentation of completed decision matrix, and a recommended flood control plan. This report will be presented at a review meeting with the client and other interested parties.
- Complete set of construction drawings submitted at:
    - 30%, 60%, 90%, Issued for Construction.

    - A client meeting will be held with each submittal
    - Each submittal will include a design report with a preliminary construction cost estimate.
    - Specifications will be provided with the 90% submittal and Issued for Construction Drawings.
    - An invoice for work completed will be provided at each submittal
- A Final Report, including:
    - Oral Presentation to client
    - Oral Presentation at Symposium
    - Poster Presentation at Symposium

Section 4: Project Plan

To meet the requested scope of services, the team is proposing the following phasing plan to complete the work.

- **Phase 1 – Site Investigation**
- **Phase 2 – Survey**
- **Phase 3 – Preliminary Design**
- **Phase 4 – Final Design**

Phase 1 – Site Investigation

The purpose of this task is to gather site data and information for future engineering design work. Subtasks during Phase 1 shall include but are not limited to:

- Research TDOT Culvert Requirements
    - Research will be conducted to obtain the TDOT standards for culverts in order to make a comparison between the performance of existing culverts, and the performance standards set out by TDOT.
- Research ROW / Utility Constraints
    - ROW boundaries will be determined from plats and will be used during the design phase.
    - Utility Easements will be determined using plats as well as field located using TN 411 . These will be used during the design phase.
- Research Historical Flood Data
    - A well-developed storm history will be developed using NOAA public information.
- Site Visits
    - The team will perform site visits to obtain any needed information such as pictures, measurements, or additional survey data.

Phase 2- Survey

The purpose of this task is to gather data that will be used to build a topographic map. This topo map will be the basis for preliminary design solutions. The mapping will provide contours at one foot intervals. The Pegram Flood Team will prepare the topographic map using CAD software. Subtasks during Phase 2 shall include but are not limited to:

- Delineate Survey Boundary
  - Using Google maps, a general survey boundary will be created to ensure sufficient survey data is collected.
- Present Project to Survey Team
  - A presentation will be made to inform the survey team of the needs for the survey.
- Preliminary Survey
  - The design team will perform a preliminary survey at the site to find benchmarks and set control points for the survey team.
- Provide Oversight to Survey Team
  - the design team will accompany the survey team to provide assistance and oversight to the team as they perform the survey.
- Produce Topographic Map / Site Plan
  - The survey data will be transferred into AutoCAD to produce a Topo Survey. This will be used as a basis for design.

Phase 3- Preliminary Design

The purpose of this task will be to determine possible design solutions so that the team can make a recommendation to the City of Pegram for a proposed solution and the City can provide input on which design they believe will suit their needs. Subtasks during Phase 3 shall include but are not limited to:

- Delineate Drainage Basin
  - Using USGS Topo Maps, a drainage basin may be obtained by using the contour lines.
- NCRS TR - 55 Method of Analysis
  - The survey and drainage basin data will be used in the NCRS TR-55 methodology. The Time of concentration will be acquired through this process.

- Culvert Analysis
  - Hydraulic capacity of the current culverts will be evaluated from the known dimensions of the culverts.
  - This data will be compared with the TDOT standards for culverts to determine if the current culvert meets the requirements.
- Preliminary Detention Design
  - For our purposes, the use of detention basins will be investigated in multiple locations. The simplified steps for design will be as follows:
    - Estimate the preliminary storage volume
    - Use site topography to prepare a preliminary layout of a detention basin that has the desired volume and outlet configuration.
    - Determine stage-storage-outflow characteristics of the trial pond size.
    - Perform routing of input hydrographs through the pond.
- Preliminary Ditch Improvement Design
  - Ditch modifications will be analyzed to determine the feasibility of improving the efficiency of channel flow to alleviate flooding
  - The use of In-Channel Bio Retention will also be investigated.
- Preliminary Culvert Improvement Design
  - Using the data from the culvert analyses performed during the *Site Investigation* phase, the team will design to either resize the current culverts or add supplementary culverts underneath highway 70, Juniper Drive, and Hannah Ford Road
- Create Decision Matrix
  - The criteria for decision matrix are as follows:
    - Cost
    - Maintenance
    - Feasibility
    - Performance
    - Longevity
    - Degree of Disruption

Phase 4 – Final Design

The purpose of this task is to fully design the method, or combinations of methods chosen by the Design Team in conjuncture with the City, and to produce complete construction documents and specifications to present to the City of

Pegram. All work during this phase will be done to produce the deliverables listed in ***Section 3: Scope of Services.***

Section 5: Quality Assurance / Project Management

The quality of the design work provided will be monitored by the project manager and by all members of the design team. The quality of the work will be monitored in the following ways:

- Action Items
  - An action items spreadsheet will be maintained by the project manager and will be sent out at the beginning of each week so that all team members know what tasks they are responsible for.
- Weekly Timesheets
  - All hours worked by each team member will logged on a weekly timesheet and sent to the Assistant Project Manager each Friday.
- Weekly Progress Meetings
  - The team will hold a weekly meeting to monitor the quality and progress of the work which each respective team member is responsible for.
- Technical Advisor Meetings
  - The team will hold meetings with technical advisors at milestone checkpoints throughout the duration of the project.
  - The professional advisors for this project are listed in ***Section 2: Design Team***
  - These meetings will serve to allow the advisors to make comments and suggestions to help increase the quality of the design work.

Section 6: Time Estimations

The client will only be billed for hours worked. The team will not exceed the estimated number of hours without consulting the client. The current task and time estimates can be seen in ***Enclosure (B) Preliminary Work Breakdown Structure.***

Section 7: Schedule

A working copy of the project schedule was developed in Microsoft Project and is included as an attachment. The schedule will be maintained by the Project Manager and will be available upon request. The Estimated Project Schedule is attached in ***Enclosure (C) Preliminary Project Schedule.***

The dates for each submittal are listed below. Please plan on meeting within a week of each submittal for review.

Date Due	**Deliverable**
January 24, 2017	Completed Decision Matrix with selected plan & 30% Submittal
February 14, 2017	60% Submittal
March 7, 2017	90% Submittal
March 28, 2017	Final Design Report
April 11, 2017	IFC Drawings and Specifications

Section 8: Closing

Lipscomb University Senior Design Team appreciates the opportunity to work on this project. The team Is available to meet with you to discuss the proposed work, or to discuss any modifications that may need to be made to the proposal to fit your needs. We look forward to working with you.

Sincerely,

 -David A. Lowery

___________________________ - Charles Morehead

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Enclosure (B):

Preliminary Work Breakdown Structure

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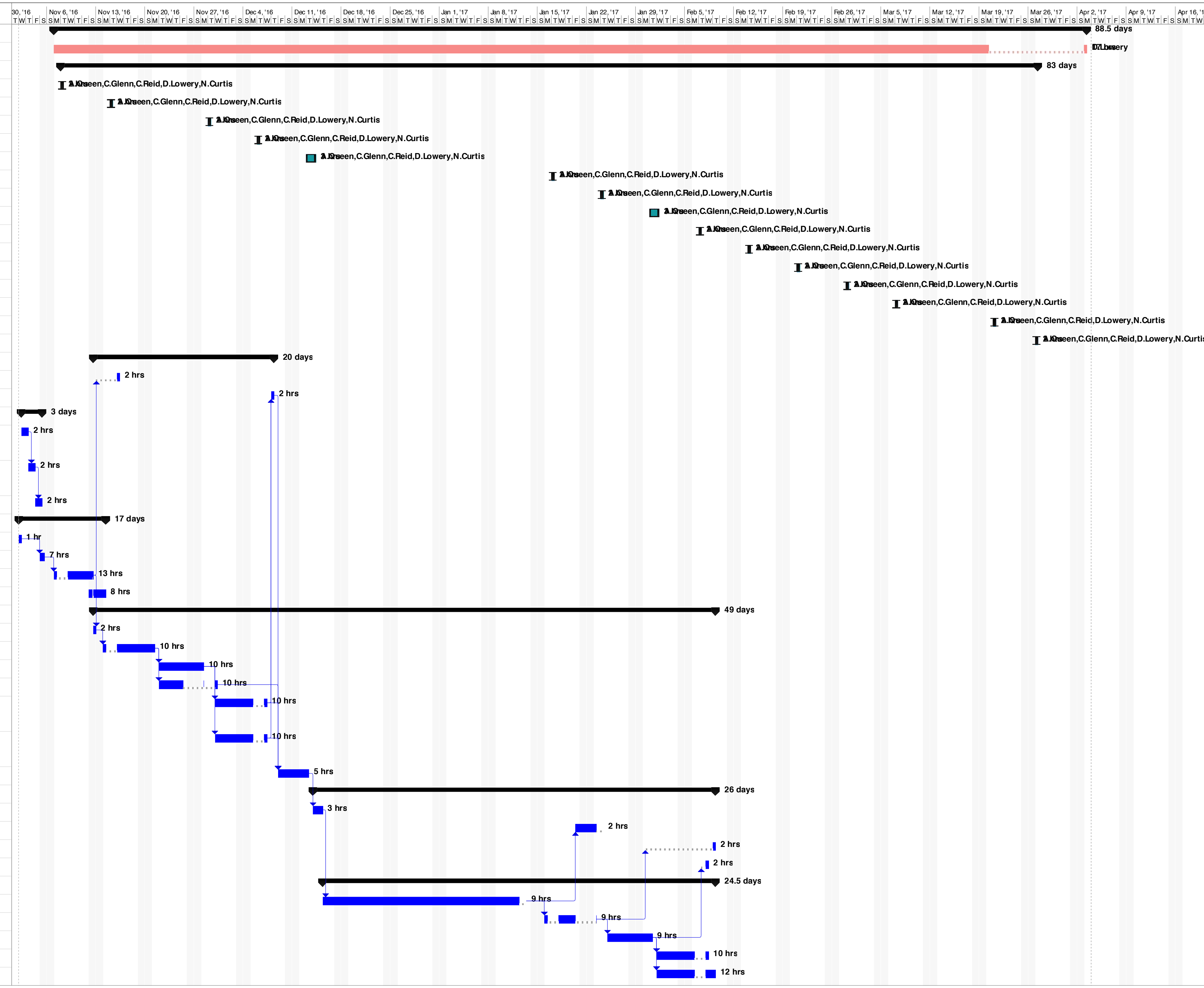
Enclosure (C):

Preliminary Project Schedule

ENCLOSURE (B) - PRELIMINARY WORK BREAKDOWN STRUCTURE

CATEGORY:	TASKS:	TEAM MEMBER	# OF TEAM	MAN HOURS	TOTAL HOURS
PROJECT MANAGEMENT					
Management	Scheduling/Planning	D.Lowery	1	17	17
	Advisor Meetings	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	5	25
	Weekly Progress Meetings	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	30	150
PHASE 1 - SITE INVESTIGATION					
Investigation	Research TDOT Requirements For Culverts	C.Reid	1	2	2
	Research ROW / Uttility Constraints	C.Reid	1	2	2
	Research Historical Flood Data	C.Reid	1	4	4
PHASE 2 - SURVEY:					
	Present Project to Survey Team	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	1	5
	Preliminary Survey Trip	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	3	15
	Provide Oversight to Survey Team	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	8	40
	Produce Topo Survey	N.Curtis,C.Glenn,A.Queen,C.Reid	1	13	13
	Additional Survey Needs	C.Glenn,C.Reid,D.Lowery,N.Curtis	4	5	20
PHASE 3 - PRELIMINARY DESIGN					
Hydraulic Analysis	Deliniate Drainage Basin	D.Lowery	1	2	2
	TR - 55 Method of Analysis	C.Glenn,N.Curtis	3	10	30
	Culvert Analysis	A.Queen,C.Reid	3	10	30
Determine Preliminary Solutions	Preliminary Detention Design	D.Lowery	2	10	20
	Preliminary Ditch Improvement Design	C.Glenn	2	10	20
	Preliminary Culvert Improvement Design	A.Queen,C.Reid	2	10	20
	Create Decision Matrix	N.Curtis,A.Queen	2	6	12
PHASE 4 - FINAL DESIGN					
Final Design	30% Submittal	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	10	50
	30% Submittal Owner Meeting	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	1	5
	60% Submittal	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	10	50
	60% Submittal Owner Meeting	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	1	5
	90% Submittal	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	10	50
	90% Submittal Owner Meeting	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	1	5
	Issued for Construction Drawings	C.Glenn,N.Curtis,C.Reid	3	10	30
	Construction Specifications	A.Queen,D.Lowery	2	5	10
	Oral Presentation To Client	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	3	15
	Oral Presentation At Symposium	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	3	15
	Poster Presentation At Symposium	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis	5	1	5
				TOTAL:	667

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**Project Management**	**88.5 days**	**Mon 11/7/16**	**Mon 4/3/17**		
2		Scheduling/Planning	17 hrs	Mon 11/7/16	Mon 4/3/17		D.Lowery
3		**Weekly Progress Meetings**	**83 days**	**Tue 11/8/16**	**Mon 3/27/17**		
4		Progress Meeting 1	2 hrs	Tue 11/8/16	Tue 11/8/16		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
5		Progress Meeting 2	2 hrs	Tue 11/15/16	Tue 11/15/16		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
6		Progress Meeting 3	2 hrs	Tue 11/29/16	Tue 11/29/16		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
7		Progress Meeting 4	2 hrs	Tue 12/6/16	Tue 12/6/16		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
8		Progress Meeting 5	3 hrs	Tue 12/13/16	Wed 12/14/16		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
9		Progress Meeting 6	2 hrs	Tue 1/17/17	Tue 1/17/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
10		Progress Meeting 7	2 hrs	Tue 1/24/17	Tue 1/24/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
11		Progress Meeting 8	3 hrs	Tue 1/31/17	Wed 2/1/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
12		Progress Meeting 9	2 hrs	Tue 2/7/17	Tue 2/7/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
13		Progress Meeting 10	2 hrs	Tue 2/14/17	Tue 2/14/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
14		Progress Meeting 11	2 hrs	Tue 2/21/17	Tue 2/21/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
15		Progress Meeting 12	2 hrs	Tue 2/28/17	Tue 2/28/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
16		Progress Meeting 13	2 hrs	Tue 3/7/17	Tue 3/7/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
17		Progress Meeting 14	2 hrs	Tue 3/21/17	Tue 3/21/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
18		Progress Meeting 15	2 hrs	Mon 3/27/17	Mon 3/27/17		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
19		**Advisor Meetings**	**20 days**	**Sat 11/12/16**	**Thu 12/8/16**		
20		Advisor Meeting 1	2 hrs	Sat 11/12/16	Wed 11/16/16	29	C.Glenn,C.Reid,D.Lowery,N.Curtis,A.Queen
21		Advisor Meeting 2	2 hrs	Thu 12/8/16	Thu 12/8/16	36,37	C.Glenn,C.Reid,D.Lowery,N.Curtis,A.Queen
22		**Phase 1 - Site Investigation**	**3 days**	**Wed 11/2/16**	**Sat 11/5/16**		
23		Research TDOT Requirements For Culverts	2 hrs	Wed 11/2/16	Thu 11/3/16		C.Reid
24		Research ROW / Uttility Constraints	2 hrs	Thu 11/3/16	Fri 11/4/16	23	C.Reid
25		Research Historical Flood Data	2 hrs	Fri 11/4/16	Sat 11/5/16	24	C.Reid
26		**Phase 2 - Survey**	**17 days**	**Wed 11/2/16**	**Mon 11/14/16**		
27		Present Project to Survey Team	1 hr	Wed 11/2/16	Wed 11/2/16		C.Glenn,C.Reid,D.Lowery,N.Curtis,A.Queen
28		Provide Oversight to Survey Team	7 hrs	Sat 11/5/16	Sat 11/5/16	27	C.Glenn,C.Reid,D.Lowery,N.Curtis,A.Queen
29		Produce Topo Survey	13 hrs	Mon 11/7/16	Sat 11/12/16	28	N.Curtis,C.Glenn,A.Queen,C.Reid
30		Additional Survey Needs	8 hrs	Sat 11/12/16	Mon 11/14/16		A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
31		**Phase 3 - Preliminary Design**	**49 days**	**Sat 11/12/16**	**Thu 2/9/17**		
32		Deliniate Drainage Basin	2 hrs	Sat 11/12/16	Sat 11/12/16	29	D.Lowery
33		TR - 55 Method of Analysis	10 hrs	Mon 11/14/16	Mon 11/21/16	32	C.Glenn,N.Curtis
34		Culvert Analysis	10 hrs	Tue 11/22/16	Mon 11/28/16	33	A.Queen,C.Reid
35		Preliminary Detention Design	10 hrs	Tue 11/22/16	Wed 11/30/16	33	D.Lowery
36		Preliminary Ditch Improvement Design	10 hrs	Wed 11/30/16	Wed 12/7/16	34	C.Glenn
37		Preliminary Culvert Improvement Design	10 hrs	Wed 11/30/16	Wed 12/7/16	34	A.Queen,C.Reid
38		Create Decision Matrix	5 hrs	Fri 12/9/16	Tue 12/13/16	35,36,37	N.Curtis
39		**Owner Meetings**	**26 days**	**Wed 12/14/16**	**Thu 2/9/17**		
40		Owner Meeting 1	3 hrs	Wed 12/14/16	Thu 12/15/16	38	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
41		Owner Meeting 30%	2 hrs	Fri 1/20/17	Tue 1/24/17	45FS+5 d	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
42		Owner Meeting 60%	2 hrs	Mon 1/30/17	Thu 2/9/17	46FS+5 d	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
43		Owner Meeting 90%	2 hrs	Tue 2/7/17	Wed 2/8/17	47FS+5 d	A.Queen,C.Glenn,C.Reid,D.Lowery,N.Curtis
44		**Phase 4 - Final Design**	**24.5 days**	**Thu 12/15/16**	**Thu 2/9/17**		
45		30% Submittal	9 hrs	Thu 12/15/16	Fri 1/13/17	40	D.Lowery,N.Curtis,C.Reid
46		60% Submittal	9 hrs	Mon 1/16/17	Mon 1/23/17	45	D.Lowery,N.Curtis,C.Reid
47		90% Submittal	9 hrs	Wed 1/25/17	Tue 1/31/17	46	D.Lowery,N.Curtis,C.Reid
48		Produce Construction Drawings	10 hrs	Wed 2/1/17	Wed 2/8/17	47	C.Glenn,N.Curtis
49		Produce Necessary Narratives	12 hrs	Wed 2/1/17	Thu 2/9/17	47	A.Queen,D.Lowery



Project: Project1
Date: Tue 10/25/16

Task	Summary	Rolled Up Task	Rolled Up Progress	Inactive Task	Manual Task	Manual Summary	Deadline	Critical Split	
Split	Project Summary	Rolled Up Critical Task	External Tasks	Inactive Milestone	Duration-only	Start-only	Critical Task	Progress	
Milestone	Group By Summary	Rolled Up Milestone	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only	Critical		

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Enclosure (C):

Concept Plan & Historical Review

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Enclosure (D):

Existing Conditions Package

Existing Conditions of the Pegram Highway 70 Culverts
Technical Report

Highway 70 Shopping Area
500 Block Hwy 70
Pegram, TN 37143

Enclosures:

A. Survey – Existing Conditions
B. Watershed Delineation Map
C. Soil Report
D. Land Use Map
E. Hydrology Report
F. Culvert Analysis Report

Contributors:
Nathan Curtis
David Lowery
Cody Glenn
Abigail Queen
Christian Reid

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Introduction:

The Lipscomb University senior design team was asked by the city of Pegram to address a flooding issue that takes place at three culverts running under Highway 70. It was apparent that these culverts were not meeting TDOT standards, however there was no qualitative data to back up the claim. The following is our analysis of the existing conditions of the culverts at the 500 block of Hwy 70 as well as the culverts along the flow path to the 500 block of Hwy 70.

Research & Analysis:

We set out in the fall of 2017 to gather survey data around the place of flooding, in hopes that it would help inform our hydraulic analysis. Our survey covered the area bounded by Highway 70, Dogwood Lane, and Hannah Ford Road. The completed survey can be seen in enclosure (A). This data, along with GIS data, was used to analyze the watershed and current culvert conditions. We found that each of the culverts along the flow path of interest (flowing south from Hannah Ford Rd along the ditch to HWY 70), are failing per TDOT standards as seen in Figure 1.

TDOT Standards:

	Interstate System and Arterial With Full Access Control	Arterial Without Full Access Control	Collector	Local Road
Inlet Design Frequency	50-yr	10-yr [1]	10-yr [1]	10-yr
Sewer Design Frequency	50-yr	10-yr [1]	10-yr [1]	10-yr
Culvert Design Frequency	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr
Roadway Freeboard [2]	50-yr	50-yr	50-yr	50-yr
Ditch Design Frequency	50-yr	10-yr [1]	10-yr [1]	10-yr

Figure 1 TDOT Current Culvert Standards

Per the TDOT standards shown above, all culverts are to be designed for a 50 year storm, and if feasible, for the 100 year storm. Each of the culverts along the flow path are failing under the 50-year storm conditions.

For ease of reference, *Figure 2 (Left)* shows the naming convention used for each of the culverts along the flow path. This can be seen in more detail in *Enclosure (A).*

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The results of our analysis for a 50 year storm event can be seen summarized in Table 1 below, and in more detail in *enclosures (E)& (F).*

CULVERT DATA ALONG FLOWPATH FOR 50 YEAR STORM – EXISTING						
CULVERT NAME	# OF CULVERTS	SIZE OF CULVERTS	CULVERT CAPACITY (CFS)	TOTAL INCOMING FLOW (CFS)	FLOW OVERTOPPING (CFS)	DEPTH OF FLOW OVERTOPPING ROAD
1	1	36X60" ELLIPTICAL	106	148	41	3 IN.
2	1	36" ROUND	68	103	34	1.8 IN.
3	3	36" ROUND	143	172	28	2.4 IN.
4	3	18X30" ELLIPTICAL	64	220	125	5 IN.

Table 1 Culvert Analysis under 50-yr Storm Conditions

Conclusion:

According to our analysis, all culverts along the flow path of interest are failing at the 50-year storm. From this data, we can conclude that the problem is not only the culverts that run under highway 70 (culvert 4 in Fig 2), but all the other culverts as well. We request that TDOT review our work and consider addressing the issues we have found.

Sincerely,

David Lowery
(615) 881-3973
loweryda@mail.lipscomb.edu

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ENCLOSURE (A)

SURVEY – EXISTING CONDITIONS

CULVERT DATA ALONG FLOWPATH FOR 50 YEAR STORM – EXISTING						
CULVERT NAME	# OF CULVERTS	SIZE OF CULVERTS	CULVERT CAPACITY (CFS)	TOTAL INCOMING FLOW (CFS)	FLOW OVERTOPPING (CFS)	DEPTH OF FLOW OVERTOPPING ROAD
1	1	36X60" ELLIPTICAL	106	148	41	3 IN.
2	1	36" ROUND	68	103	34	1.8 IN.
3	3	36" ROUND	143	172	28	2.4 IN.
4	3	18X30" ELLIPTICAL	64	220	125	5 IN.

NOTES:

1. ELEVATIONS OF SURVEY BASED ON ASSUMED BENCHMARK AT ELEVATION (0,0)
2. ELEVATIONS OF HILLS NORTH OF HANNAH FORD ROAD ARE BASED ON GIS AND DO NOT CORRESPOND WITH SURVEY ELEVATIONS.
3. CULVERT CAPACITIES SHOWN IN TABLE ARE BASED ON MANNING'S EQUATION.

C 2.0

PROJ. 001

DATE 11/08/2016

EXISTING CONDITIONS

NOT FOR CONSTRUCTION

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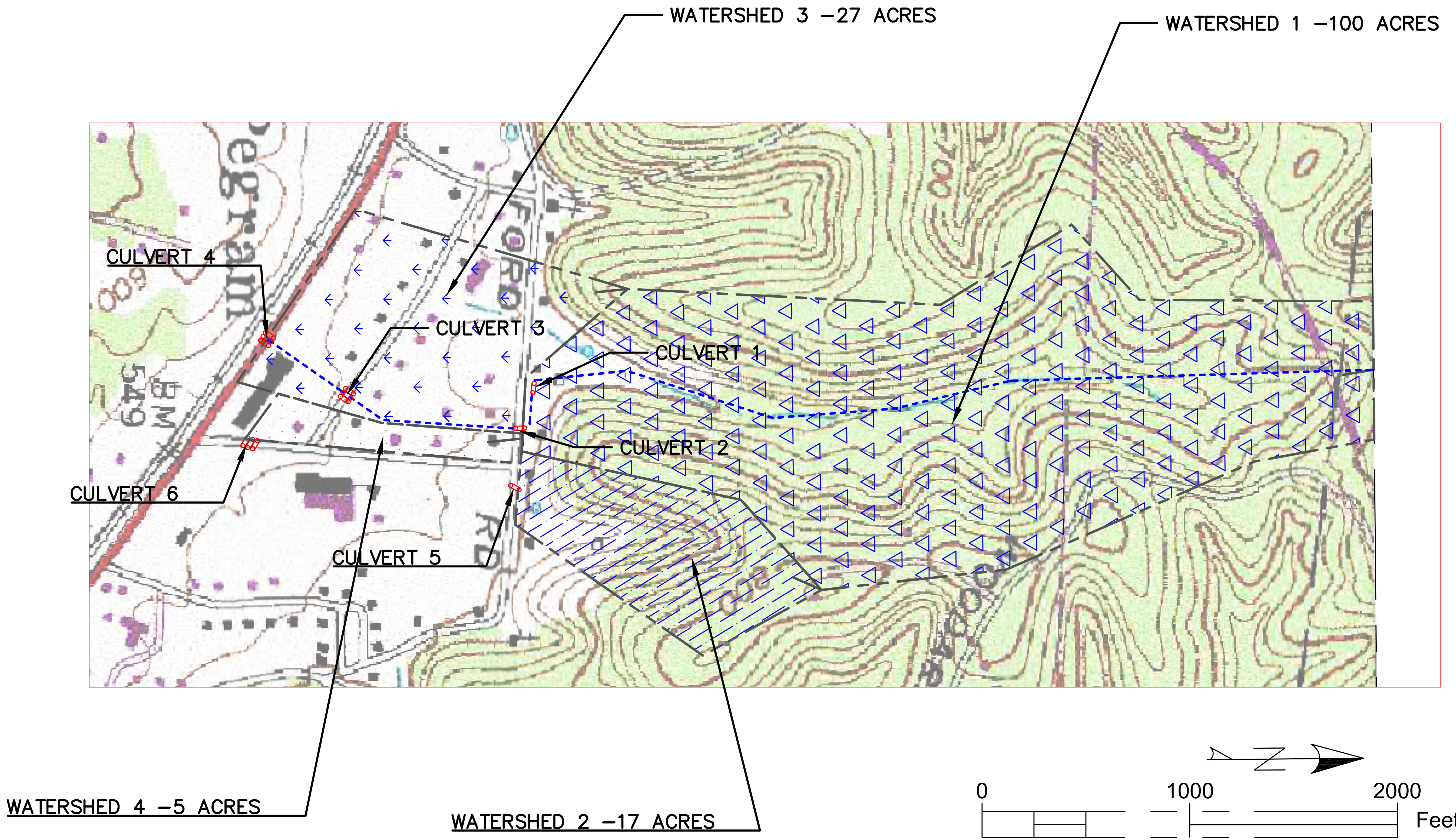
ENCLOSURE (B)

WATERSHED DELINIATION MAP

Watershed Delineation Map



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ENCLOSURE (C)

SOIL REPORT

United States Department of Agriculture

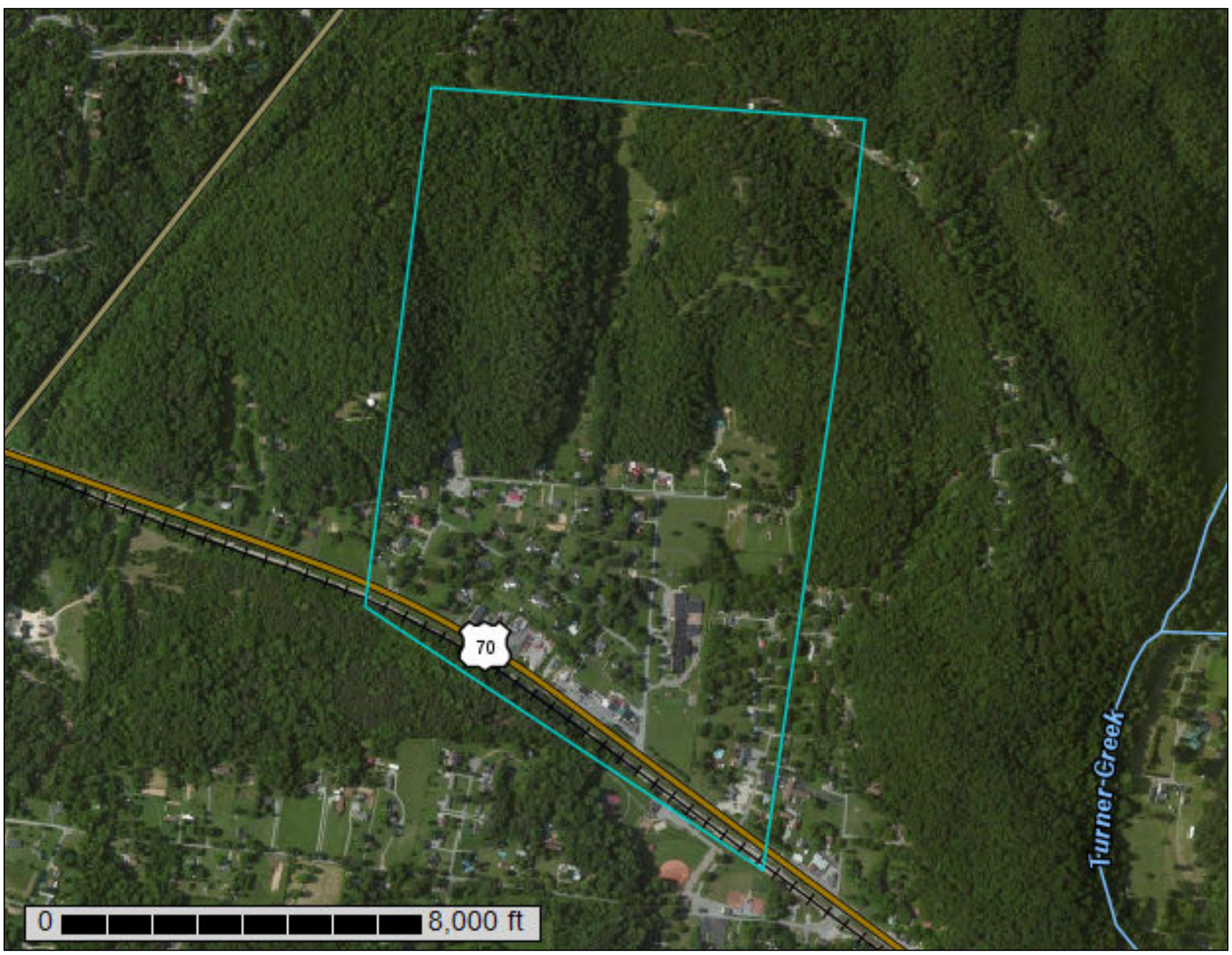
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

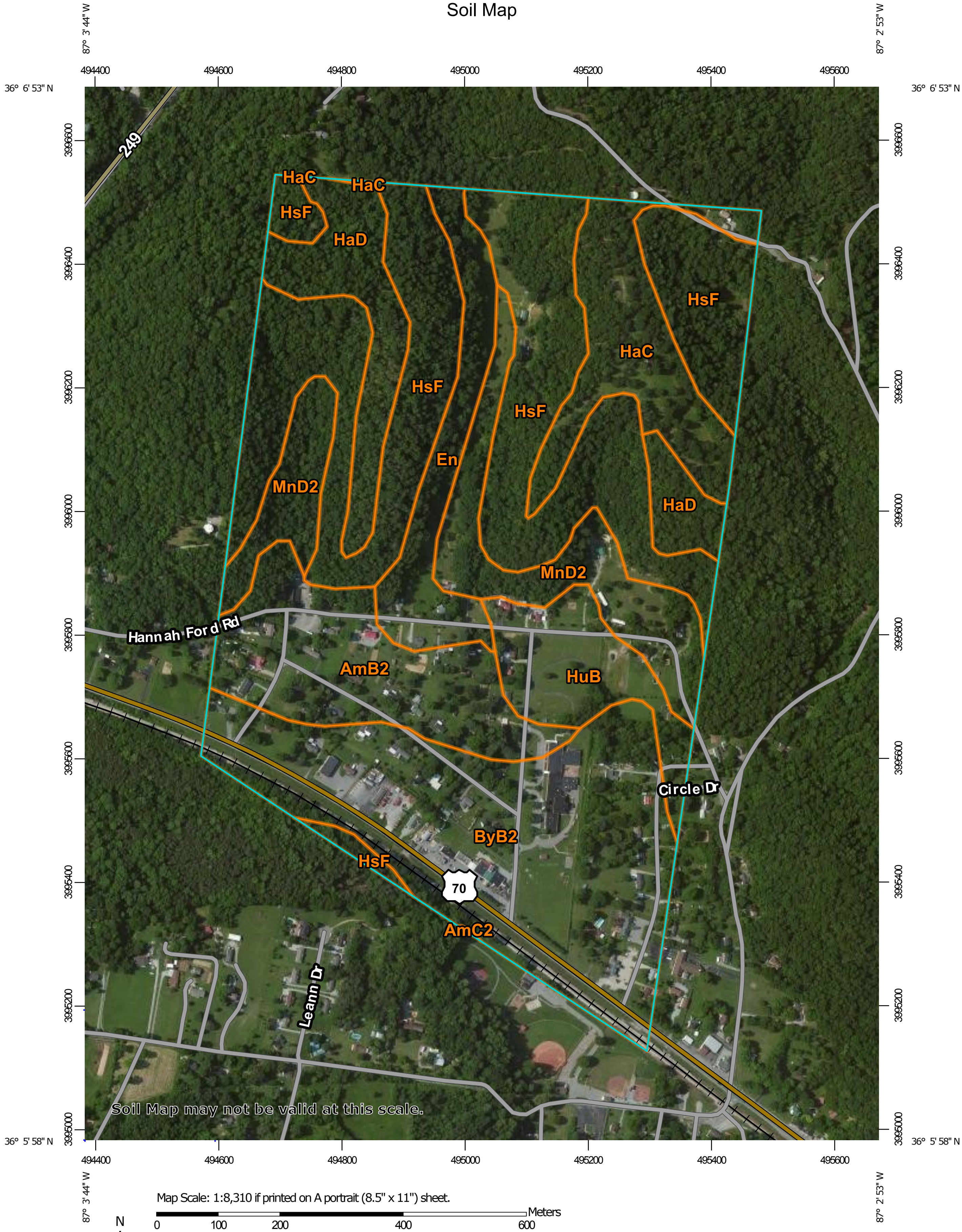
Custom Soil Resource Report for

Cheatham County, Tennessee



January 31, 2017

Soil Map



Map Scale: 1:8,310 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Cheatham County, Tennessee
Survey Area Data: Version 10, Sep 11, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 17, 2011—May 30, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Cheatham County, Tennessee (TN021)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AmB2	Armour silt loam, 2 to 5 percent slopes	23.8	10.5%
AmC2	Armour silt loam, 5 to 12 percent slopes	0.0	0.0%
ByB2	Byler silt loam, 2 to 5 percent slopes, eroded	53.3	23.4%
En	Ennis gravelly silt loam, occasionally flooded	12.8	5.6%
HaC	Hawthorne gravelly silt loam, 5 to 12 percent slopes	17.7	7.8%
HaD	Hawthorne gravelly silt loam, 12 to 20 percent slopes	16.7	7.3%
HsF	Hawthorne-Sulphura association, steep	68.1	29.9%
HuB	Humphreys gravelly silt loam, 2 to 5 percent slopes	12.6	5.5%
MnD2	Minvale gravelly silt loam, 12 to 20 percent slopes, eroded	22.7	10.0%
Totals for Area of Interest		**227.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Cheatham County, Tennessee

AmB2—Armour silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2td31
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Armour and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Armour

Setting

Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Silty alluvium over clayey residuum weathered from phosphatic limestone

Typical profile

A - 0 to 19 inches: silt loam
Bt - 19 to 58 inches: silty clay loam
BC - 58 to 79 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Byler

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Arrington

Percent of map unit: 4 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mimosa

Percent of map unit: 2 percent
Landform: Escarpments
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

AmC2—Armour silt loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2td32
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Armour and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Armour

Setting

Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread

Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Silty alluvium over clayey residuum weathered from phosphatic limestone

Typical profile

A - 0 to 19 inches: silt loam
Bt - 19 to 58 inches: silty clay loam
BC - 58 to 79 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Byler

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Dellrose

Percent of map unit: 4 percent
Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Mimosa

Percent of map unit: 2 percent
Landform: Escarpments
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex

Hydric soil rating: No

ByB2—Byler silt loam, 2 to 5 percent slopes, eroded

Map Unit Setting

National map unit symbol: kpd6
Elevation: 400 to 700 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Byler and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Byler

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium over clayey residuum weathered from limestone

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 24 inches: silt loam
H3 - 24 to 44 inches: silty clay loam
H4 - 44 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: About 24 inches to fragipan
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

En—Ennis gravelly silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: kpd9
Elevation: 900 to 1,300 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ennis and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ennis

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 7 inches: gravelly silt loam
H2 - 7 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Hydric soil rating: No

HaC—Hawthorne gravelly silt loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: kpdf
Elevation: 900 to 1,300 feet

Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Hawthorne and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawthorne

Setting

Landform: Hillslopes
Landform position (three-dimensional): Crest
Parent material: Gravelly residuum weathered from limestone and siltstone

Typical profile

H1 - 0 to 6 inches: gravelly silt loam
H2 - 6 to 33 inches: very channery silt loam
Cr - 33 to 43 inches: bedrock

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Hydric soil rating: No

HaD—Hawthorne gravelly silt loam, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2v59f
Elevation: 350 to 1,070 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 69 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Hawthorne and similar soils: 88 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawthorne

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Gravelly residuum weathered from limestone and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: gravelly silt loam
AE - 5 to 12 inches: gravelly silt loam
Bw - 12 to 18 inches: very gravelly silt loam
C - 18 to 26 inches: very gravelly silt loam
Cr - 26 to 36 inches: bedrock

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 30 inches to paralithic bedrock
Natural drainage class: Somewhat excessively drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.10 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Sugargrove

Percent of map unit: 6 percent
Landform: Hillsides
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Dellrose

Percent of map unit: 4 percent
Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear

Hydric soil rating: No

Sengtown

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

HsF—Hawthorne-Sulphura association, steep

Map Unit Setting

National map unit symbol: kpdh
Elevation: 600 to 1,300 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Hawthorne and similar soils: 60 percent
Sulphura and similar soils: 20 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawthorne

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Gravelly residuum weathered from limestone and siltstone

Typical profile

H1 - 0 to 6 inches: gravelly silt loam
H2 - 6 to 33 inches: very channery silt loam
Cr - 33 to 43 inches: bedrock

Properties and qualities

Slope: 20 to 60 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Sulphura

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Channery residuum weathered from limestone and shale

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 22 inches: very channery silt loam
R - 22 to 32 inches: bedrock

Properties and qualities

Slope: 20 to 60 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Minor components

Percent of map unit: 20 percent
Hydric soil rating: No

HuB—Humphreys gravelly silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: kpdj
Elevation: 600 to 1,200 feet
Mean annual precipitation: 46 to 60 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Humphreys and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Humphreys

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium and/or colluvium derived from limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 51 inches: gravelly silty clay loam
H3 - 51 to 60 inches: gravelly silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 60 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Hydric soil rating: No

MnD2—Minvale gravelly silt loam, 12 to 20 percent slopes, eroded

Map Unit Setting

National map unit symbol: kpdp
Elevation: 500 to 1,200 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Minvale and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minvale

Setting

Landform: Hillslopes
Landform position (three-dimensional): Base slope

Parent material: Loamy colluvium derived from cherty limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 18 inches: gravelly silt loam
H3 - 18 to 60 inches: gravelly silty clay loam

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

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ENCLOSURE (D)

LAND USE MAP

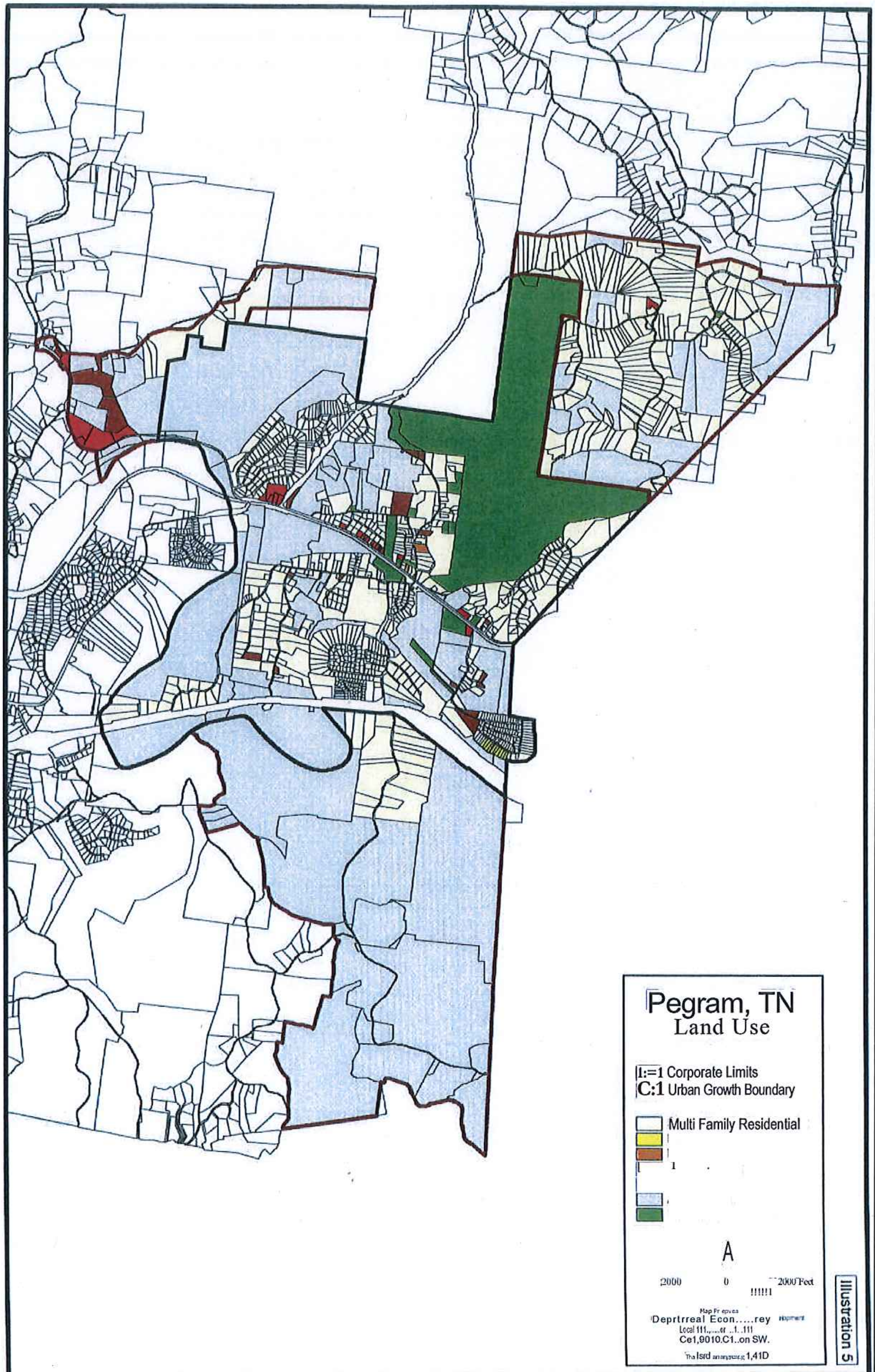

Illustration 5

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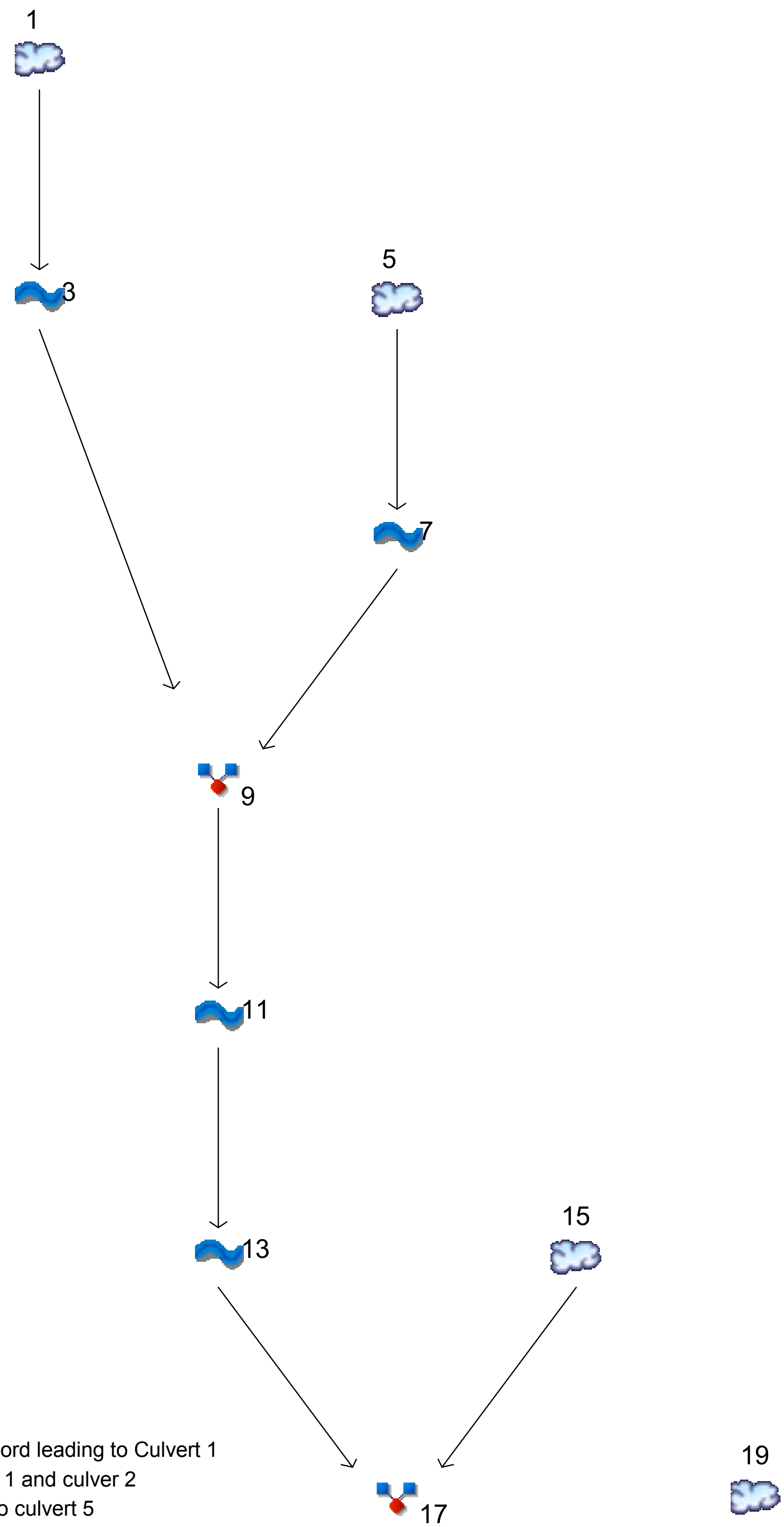
ENCLOSURE (E)

HYDROLOGY REPORT

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Legend

Hyd.	Origin	Description
1	SCS Runoff	Area Above Hannah Ford leading to Culvert 1
3	Reach	Ditch between Culvert 1 and culver 2
5	SCS Runoff	Area above culvert 5 to culvert 5
7	Reach	Ditch between culvert 5 and outfall of culvert 2
9	Combine	Junction of ditches for culvert 2 and 5
11	Reach	Ditch betweenn culverts 2 and 3
13	Reach	Channel Between Culvert 3 and 4
15	SCS Runoff	Sheet flow from houses to hwy 70
17	Combine	Flow at culverts hwy 70
19	SCS Runoff	Flow to culvert 6

Project: C:\Users\reidc\Desktop\Pegram HWY 70 Hydro Analysis Existing Conditions.gpw   Thursday, 03 / 2 / 2017

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	19.31	-------	44.33	69.68	112.65	150.27	192.30	Area Above Hannah Ford leading to
3	Reach	1	-------	19.31	-------	44.38	69.68	112.65	150.52	192.53	Ditch between Culvert 1 and culver 2
5	SCS Runoff	------	-------	11.25	-------	21.71	31.32	46.54	59.46	73.57	Area above culvert 5 to culvert 5
7	Reach	5	-------	11.24	-------	21.72	31.35	46.56	59.47	73.68	Ditch between culvert 5 and outfall of
9	Combine	3, 7,	-------	25.21	-------	55.60	85.98	137.16	182.11	231.88	Junction of ditches for culvert 2 and 5
11	Reach	9	-------	24.73	-------	54.96	85.22	136.38	181.23	230.94	Ditch betweenn culverts 2 and 3
13	Reach	11	-------	24.49	-------	54.60	84.84	135.91	180.75	230.39	Channel Between Culvert 3 and 4
15	SCS Runoff	------	-------	12.98	-------	20.93	27.87	38.53	47.37	56.85	Sheet flow from houses to hwy 70
17	Combine	13, 15,	-------	37.38	-------	75.52	112.71	174.39	228.03	287.05	Flow at culverts hwy 70
19	SCS Runoff	------	-------	5.886	-------	9.331	12.30	16.91	20.75	24.86	Flow to culvert 6

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	19.31	1	739	153,782	------	------	------	Area Above Hannah Ford leading to
3	Reach	19.31	1	740	153,781	1	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	11.25	1	725	42,927	------	------	------	Area above culvert 5 to culvert 5
7	Reach	11.24	1	726	42,926	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	25.21	1	736	196,707	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	24.73	1	739	196,705	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	24.49	1	741	196,704	11	------	------	Channel Between Culvert 3 and 4
15	SCS Runoff	12.98	1	739	71,713	------	------	------	Sheet flow from houses to hwy 70
17	Combine	37.38	1	741	268,417	13, 15,	------	------	Flow at culverts hwy 70
19	SCS Runoff	5.886	2	726	20,177	------	------	------	Flow to culvert 6

Hydrograph Report

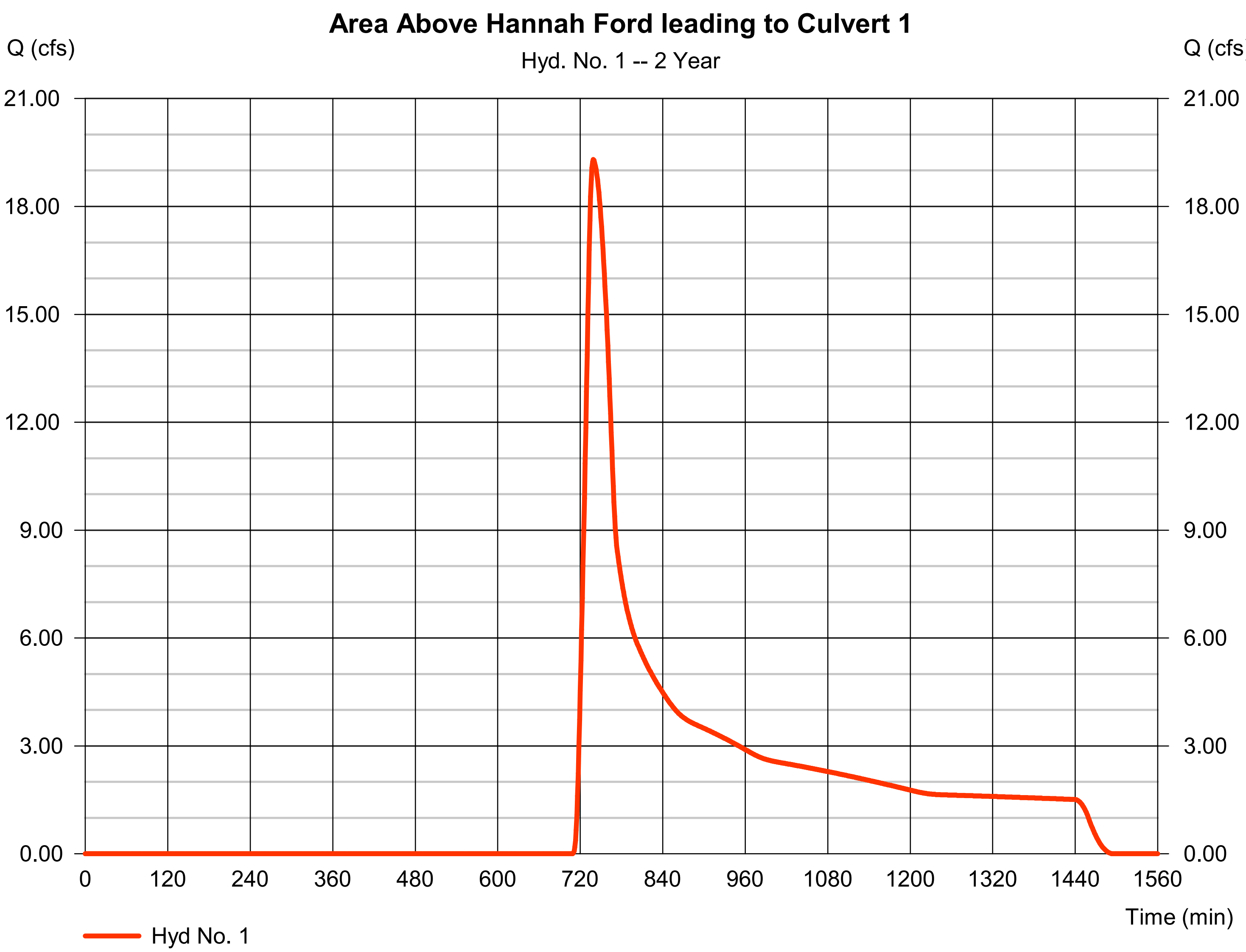
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 19.31 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 153,782 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



TR55 Tc Worksheet

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.400		0.050		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		3.62		3.62		
Land slope (%)	=	5.00		0.00		0.00		
Travel Time (min)	**=**	**19.36**	**+**	**0.00**	**+**	**0.00**	**=**	**19.36**
Shallow Concentrated Flow								
Flow length (ft)	=	1610.00		0.00		0.00		
Watercourse slope (%)	=	4.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.23			0.00		0.00		
Travel Time (min)	**=**	**8.32**	**+**	**0.00**	**+**	**0.00**	**=**	**8.32**
Channel Flow								
X sectional flow area (sqft)	=	12.00		0.00		0.00		
Wetted perimeter (ft)	=	8.00		0.00		0.00		
Channel slope (%)	=	2.00		0.00		0.00		
Manning's n-value	=	0.050		0.015		0.015		
Velocity (ft/s)	=5.53							
				0.00				
						0.00		
Flow length (ft)	({0})2346.0			0.0		0.0		
Travel Time (min)	**=**	**7.07**	**+**	**0.00**	**+**	**0.00**	**=**	**7.07**

Total Travel Time, Tc .... 34.70 min

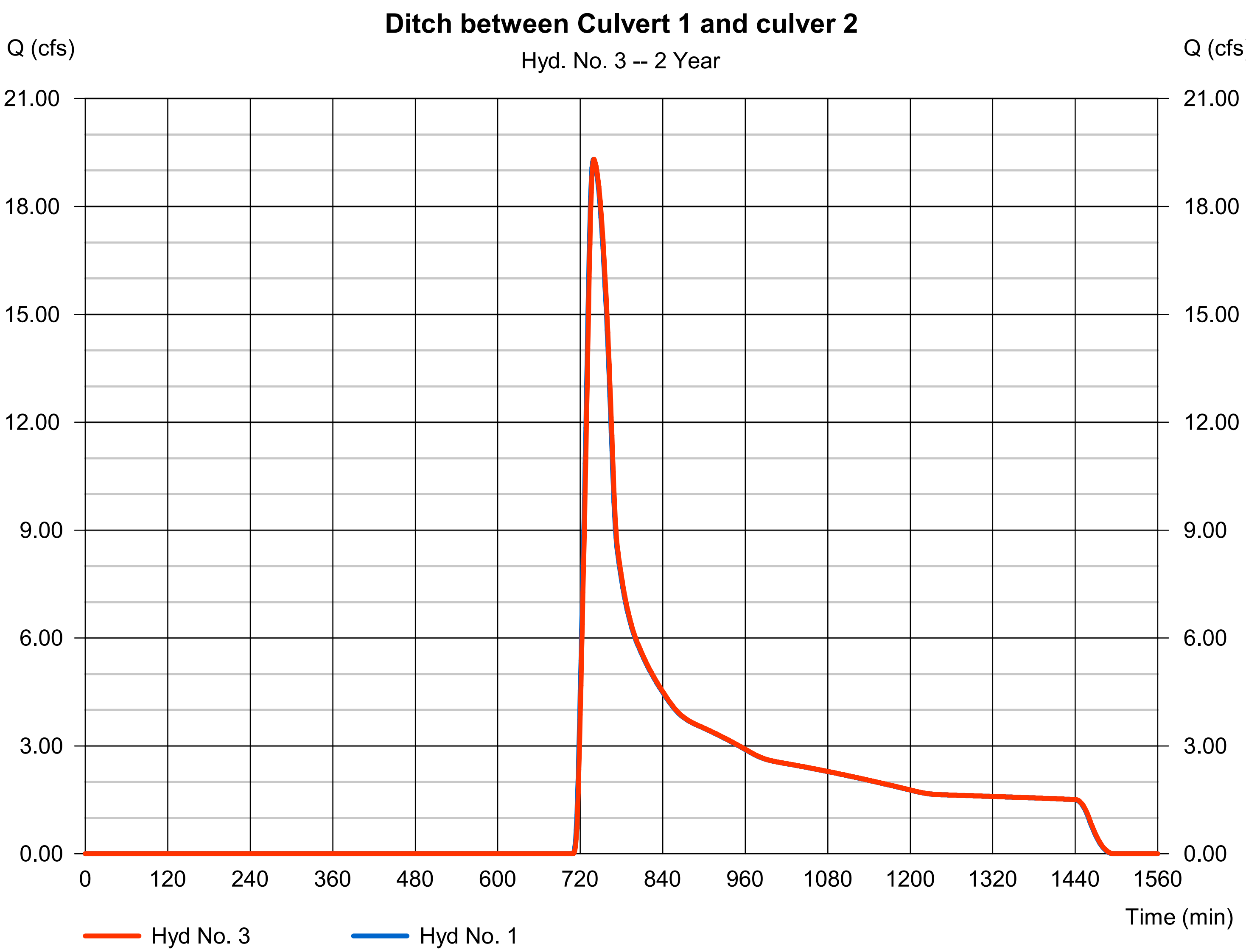
Hydrograph Report

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 19.31 cfs
Storm frequency	= 2 yrs	Time to peak	= 740 min
Time interval	= 1 min	Hyd. volume	= 153,781 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 4.74 ft/s	Routing coeff.	= 1.2129

Modified Att-Kin routing method used.



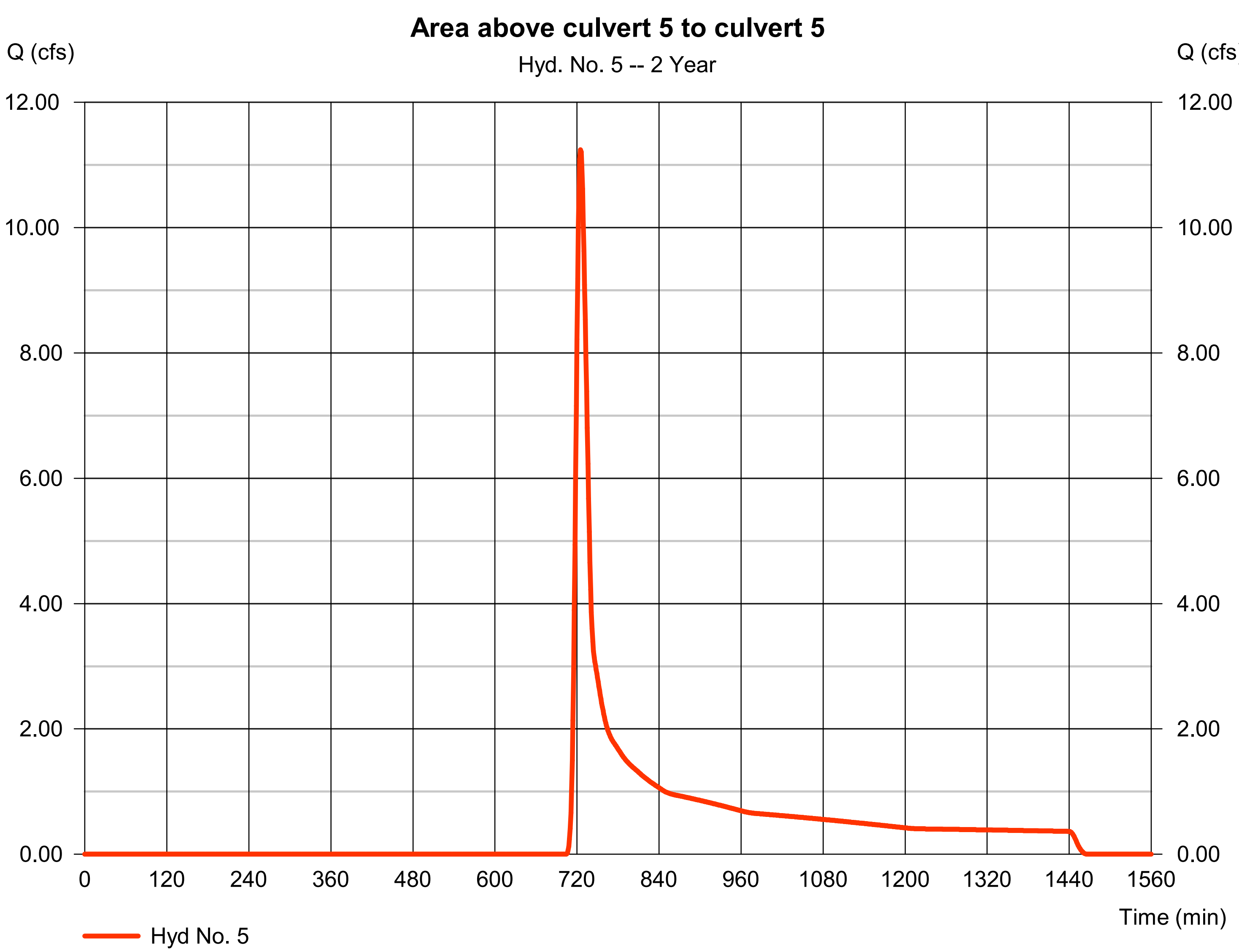
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 11.25 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 42,927 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 5

Area above culvert 5 to culvert 5

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.011		0.011		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		0.00		0.00		
Land slope (%)	=	14.00		0.00		0.00		
Travel Time (min)	**=**	**12.82**	**+**	**0.00**	**+**	**0.00**	**=**	**12.82**
Shallow Concentrated Flow								
Flow length (ft)	=	1350.00		0.00		0.00		
Watercourse slope (%)	=	12.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=5.70			0.00		0.00		
Travel Time (min)	**=**	**3.94**	**+**	**0.00**	**+**	**0.00**	**=**	**3.94**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 16.77 min

Hydrograph Report

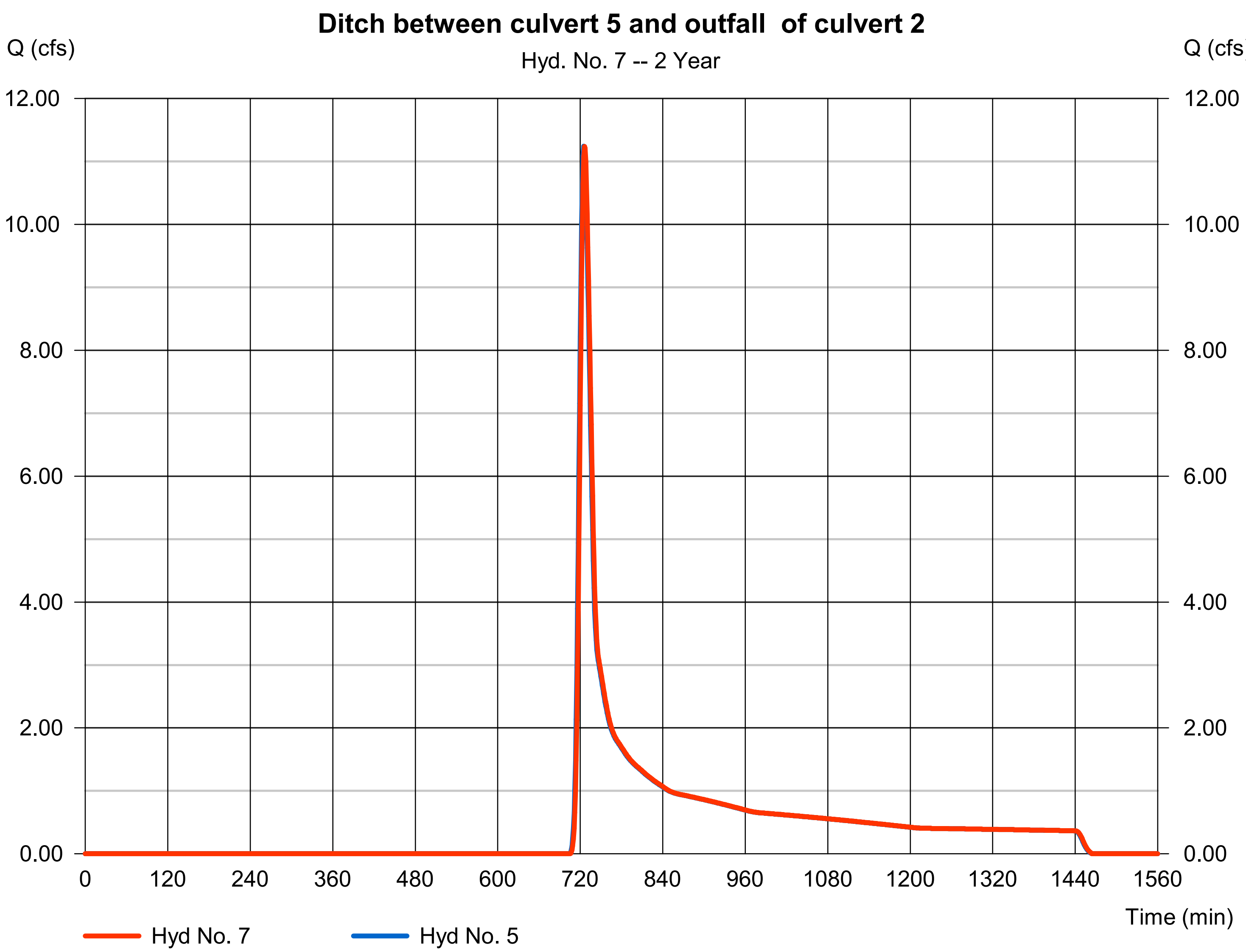
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 11.24 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 42,926 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 4.41 ft/s	Routing coeff.	= 0.9741

Modified Att-Kin routing method used.

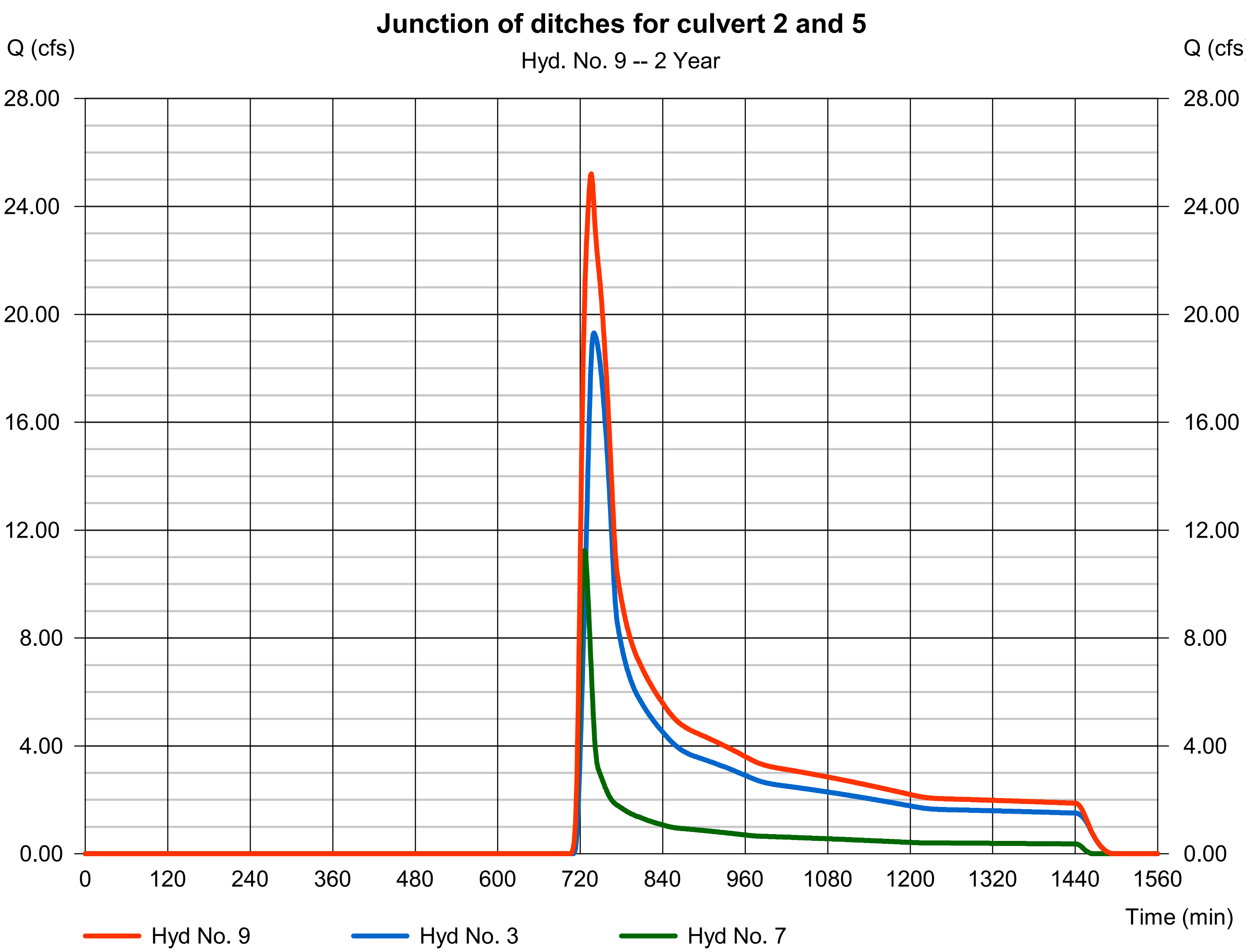


Hydrograph Report

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 25.21 cfs
Storm frequency	= 2 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 196,707 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

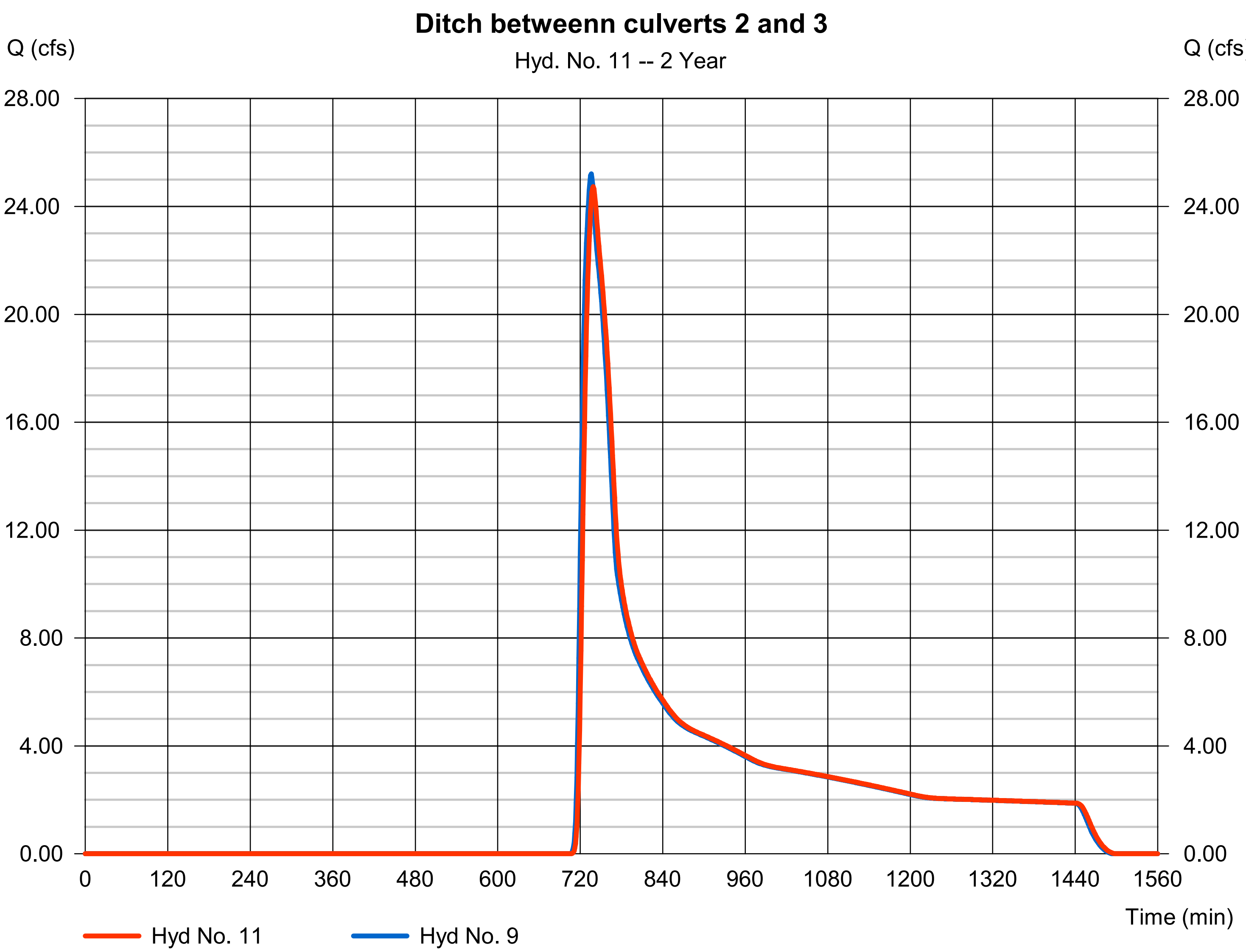
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 24.73 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 196,705 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 3.71 ft/s	Routing coeff.	= 0.3097

Modified Att-Kin routing method used.



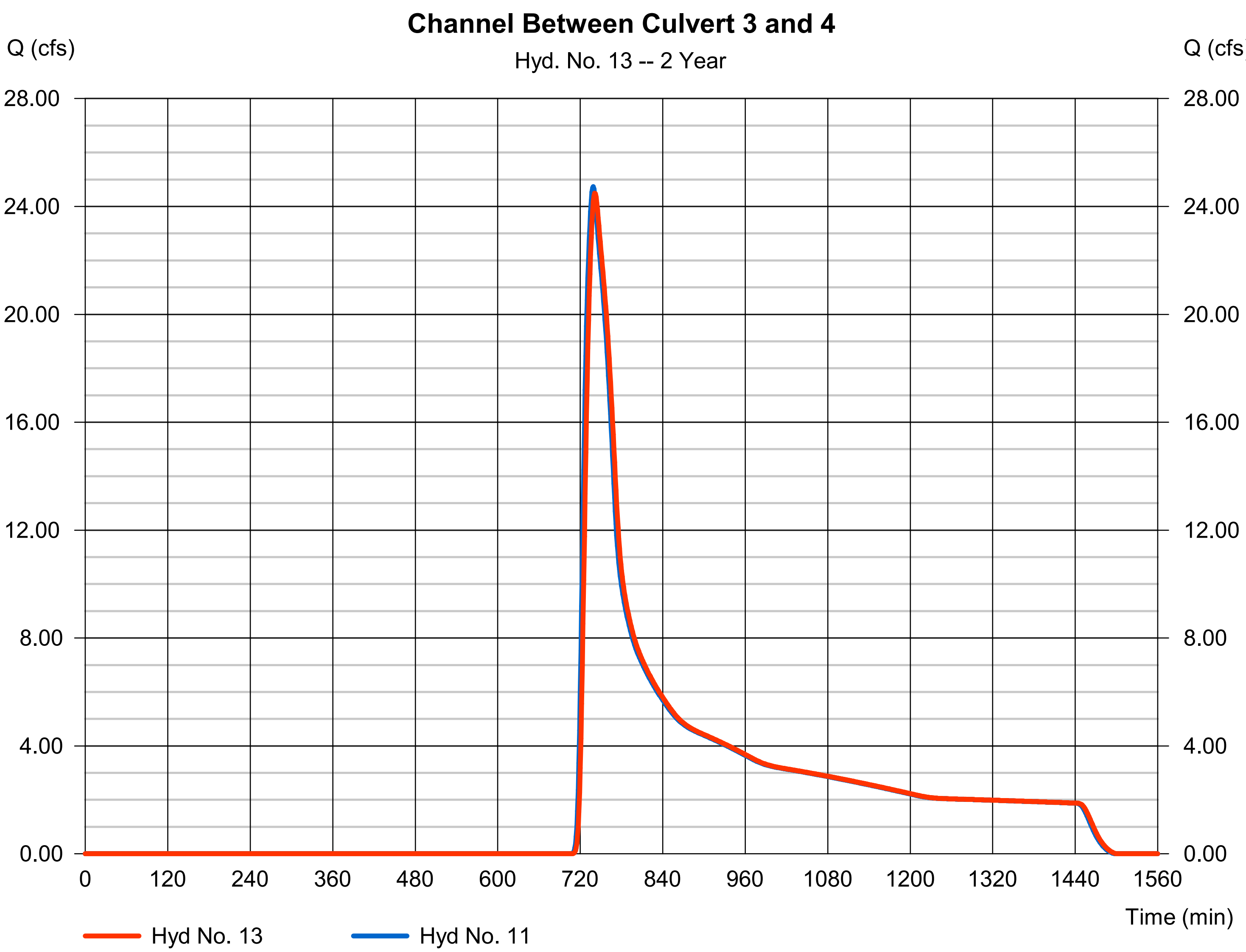
Hydrograph Report

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 24.49 cfs
Storm frequency	= 2 yrs	Time to peak	= 741 min
Time interval	= 1 min	Hyd. volume	= 196,704 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 2.80 ft/s	Routing coeff.	= 0.3961

Modified Att-Kin routing method used.



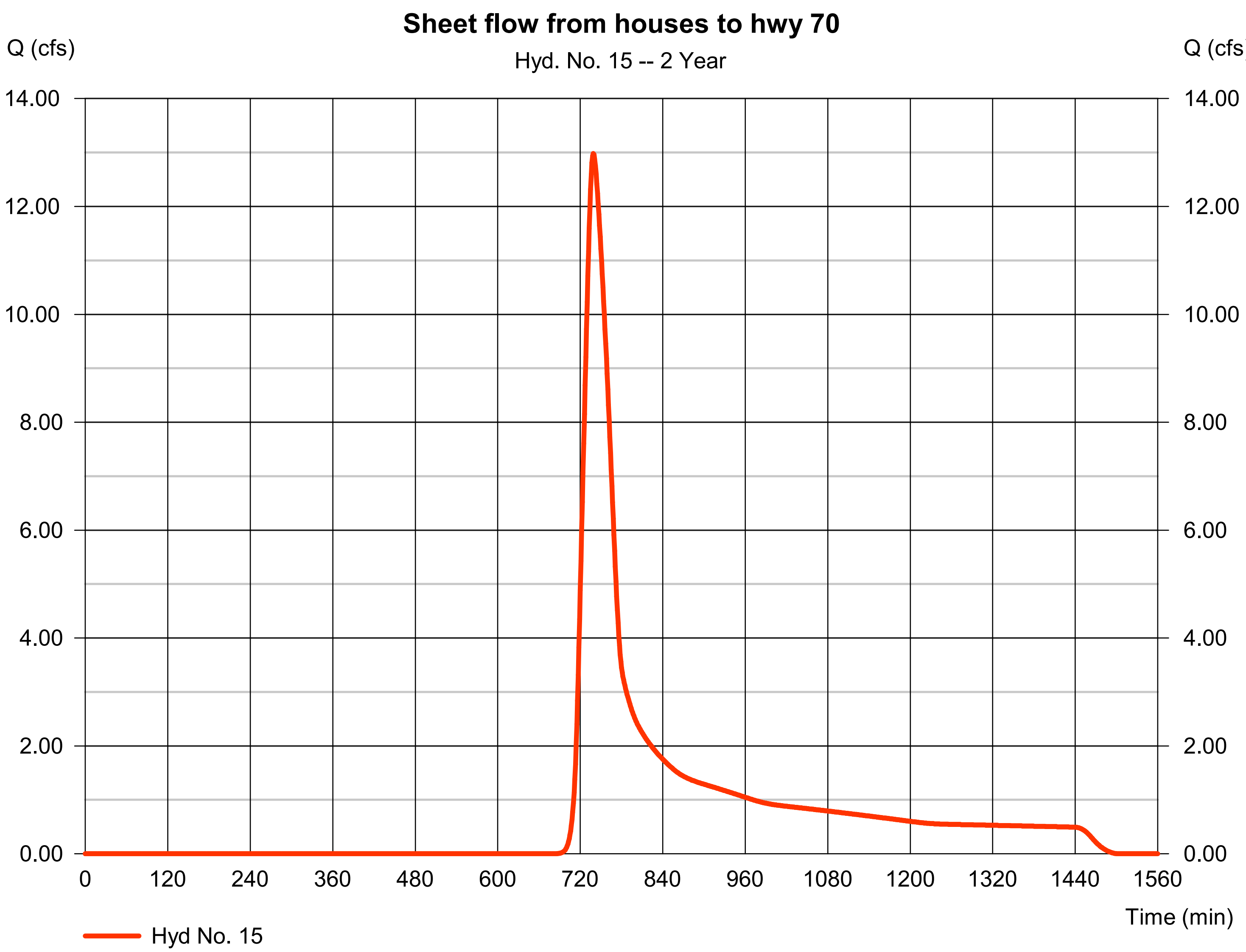
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 15

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 12.98 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 71,713 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.60 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 15

Sheet flow from houses to hwy 70

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.011		0.011		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		0.00		0.00		
Land slope (%)	=	2.00		0.00		0.00		
Travel Time (min)	**=**	**27.93**	**+**	**0.00**	**+**	**0.00**	**=**	**27.93**
Shallow Concentrated Flow								
Flow length (ft)	=	1602.00		0.00		0.00		
Watercourse slope (%)	=	2.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.28		0.00		0.00		
Travel Time (min)	**=**	**11.70**	**+**	**0.00**	**+**	**0.00**	**=**	**11.70**
Channel Flow								
X sectional flow area (sqft)	=	10.00		0.00		0.00		
Wetted perimeter (ft)	=	9.00		0.00		0.00		
Channel slope (%)	=	5.00		0.00		0.00		
Manning's n-value	=	0.025		0.015		0.015		
Velocity (ft/s)	=	14.30		0.00		0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 39.60 min

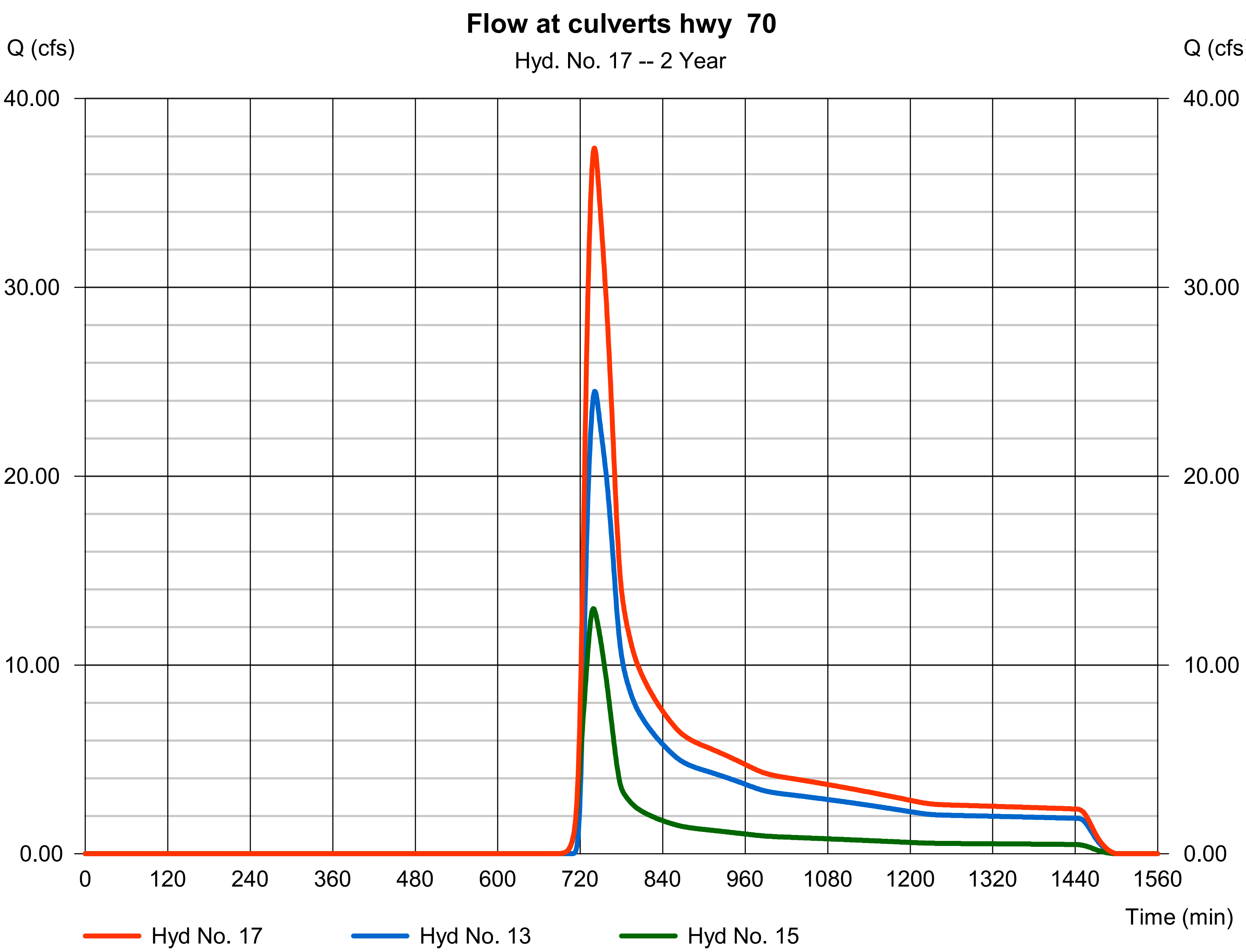
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 17

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 37.38 cfs
Storm frequency	= 2 yrs	Time to peak	= 741 min
Time interval	= 1 min	Hyd. volume	= 268,417 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 20.330 ac



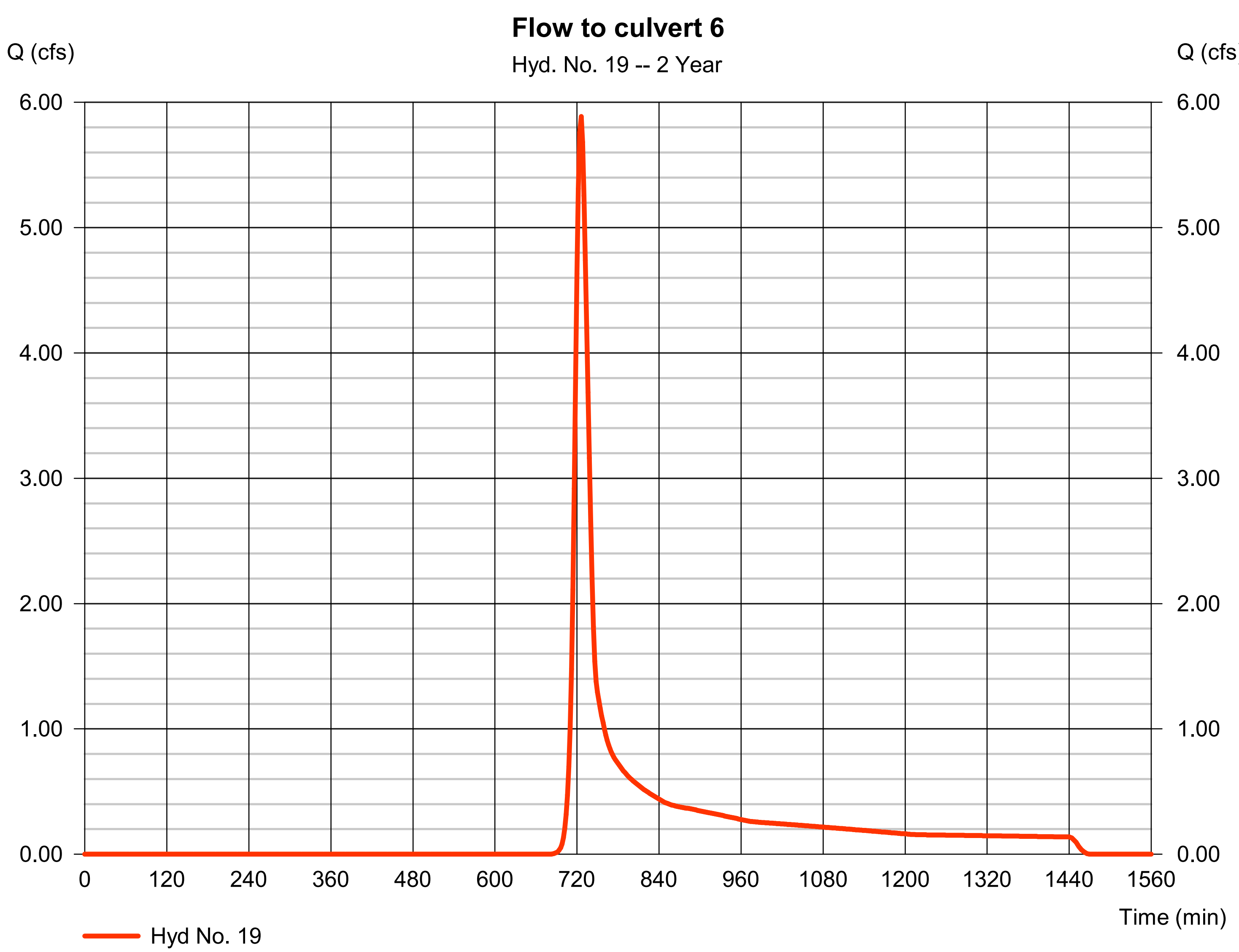
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 19

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 5.886 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 20,177 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 19

Flow to culvert 6

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		0.00		0.00		
Land slope (%)	=	2.70		0.00		0.00		
Travel Time (min)	**=**	**11.30**	**+**	**0.00**	**+**	**0.00**	**=**	**11.30**
Shallow Concentrated Flow								
Flow length (ft)	=	1030.00		0.00		0.00		
Watercourse slope (%)	=	2.70		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.65			0.00		0.00		
Travel Time (min)	**=**	**6.48**	**+**	**0.00**	**+**	**0.00**	**=**	**6.48**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **17.80 min**

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	44.33	1	737	273,458	------	------	------	Area Above Hannah Ford leading to
3	Reach	44.38	1	738	273,458	1	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	21.71	1	724	71,414	------	------	------	Area above culvert 5 to culvert 5
7	Reach	21.72	1	725	71,413	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	55.60	1	735	344,872	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	54.96	1	737	344,870	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	54.60	1	739	344,869	11	------	------	Channel Between Culvert 3 and 4
15	SCS Runoff	20.93	1	738	108,627	------	------	------	Sheet flow from houses to hwy 70
17	Combine	75.52	1	739	453,496	13, 15,	------	------	Flow at culverts hwy 70
19	SCS Runoff	9.331	2	726	30,563	------	------	------	Flow to culvert 6

Hydrograph Report

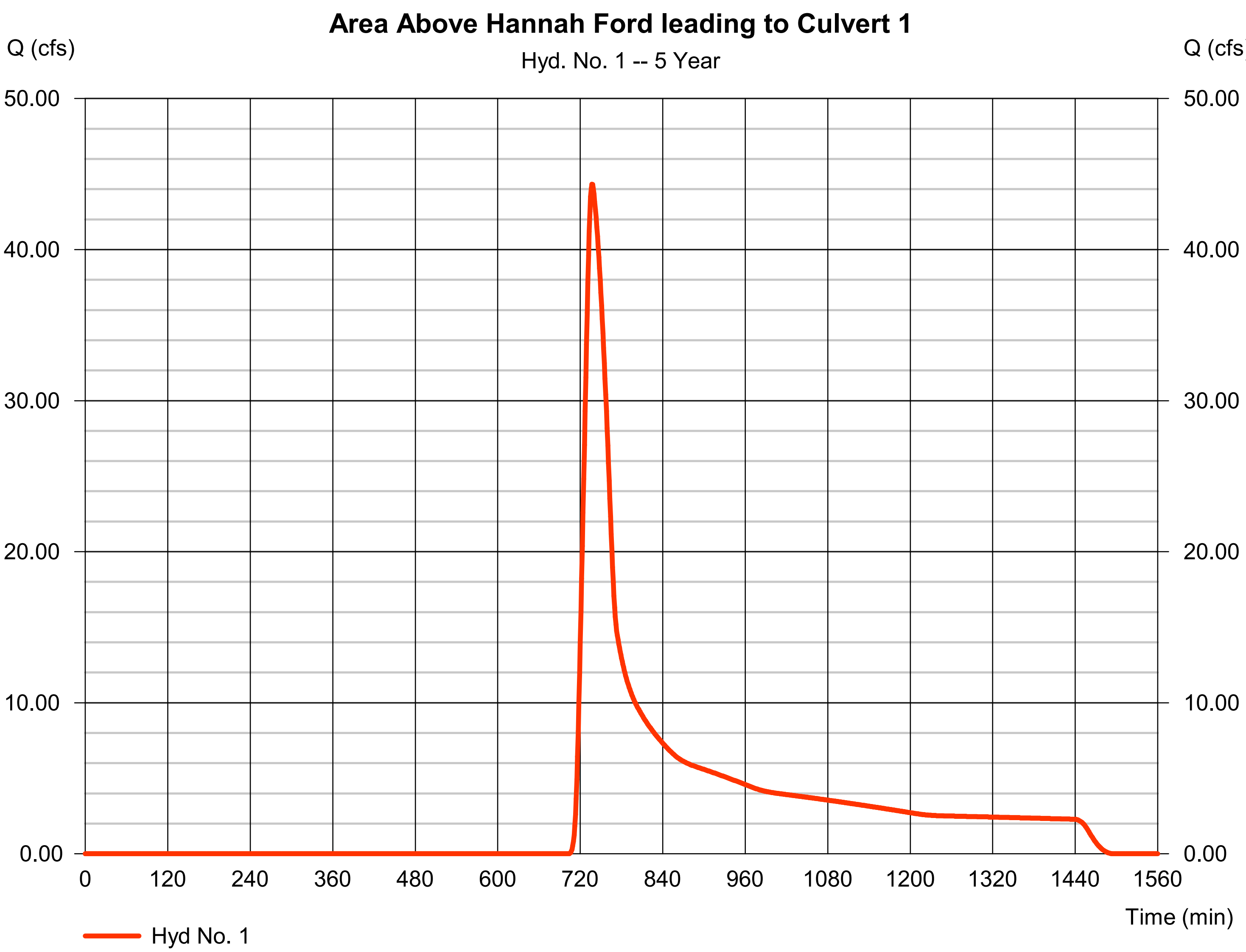
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 44.33 cfs
Storm frequency	= 5 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 273,458 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

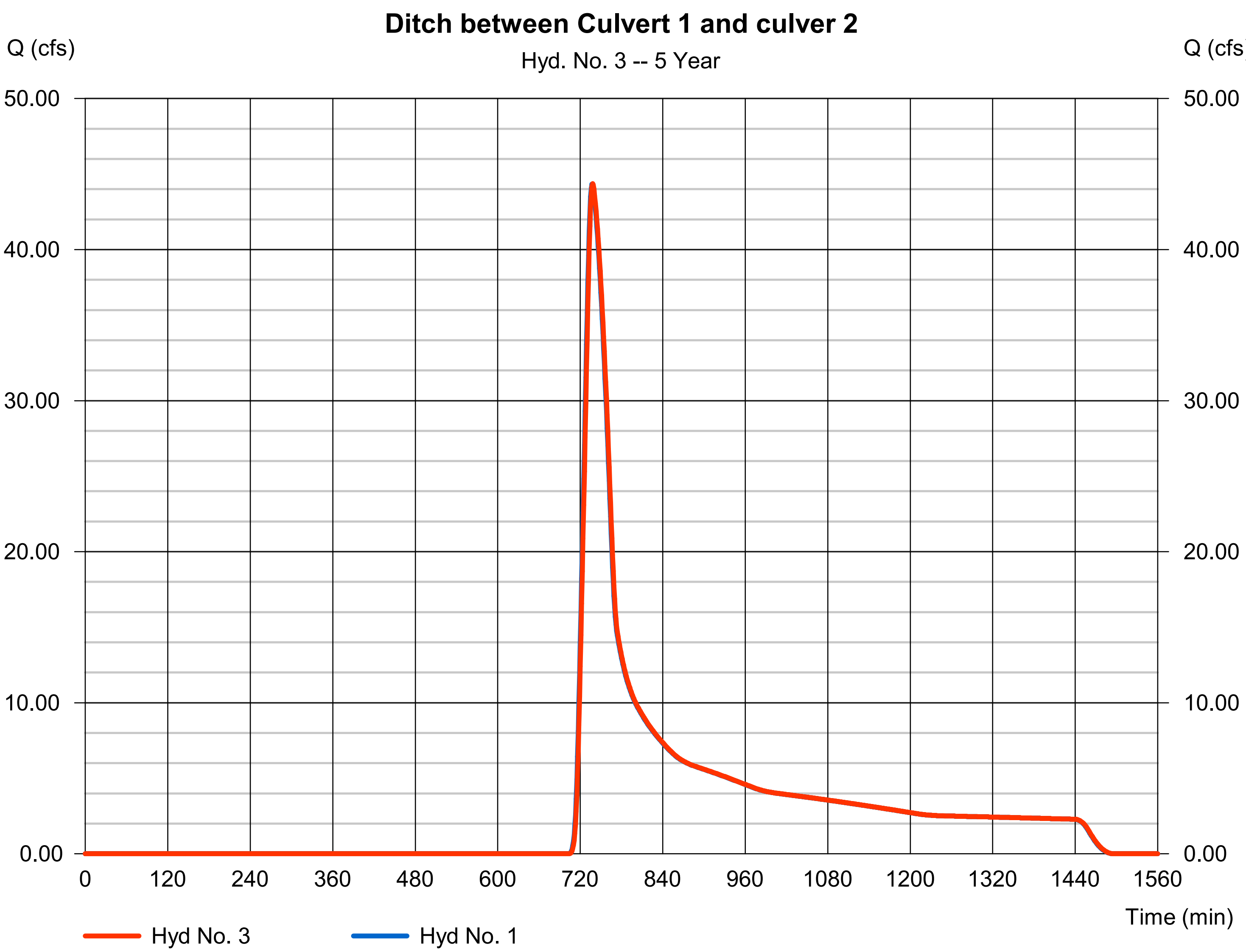
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 44.38 cfs
Storm frequency	= 5 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 273,458 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 5.68 ft/s	Routing coeff.	= 1.2975

Modified Att-Kin routing method used.



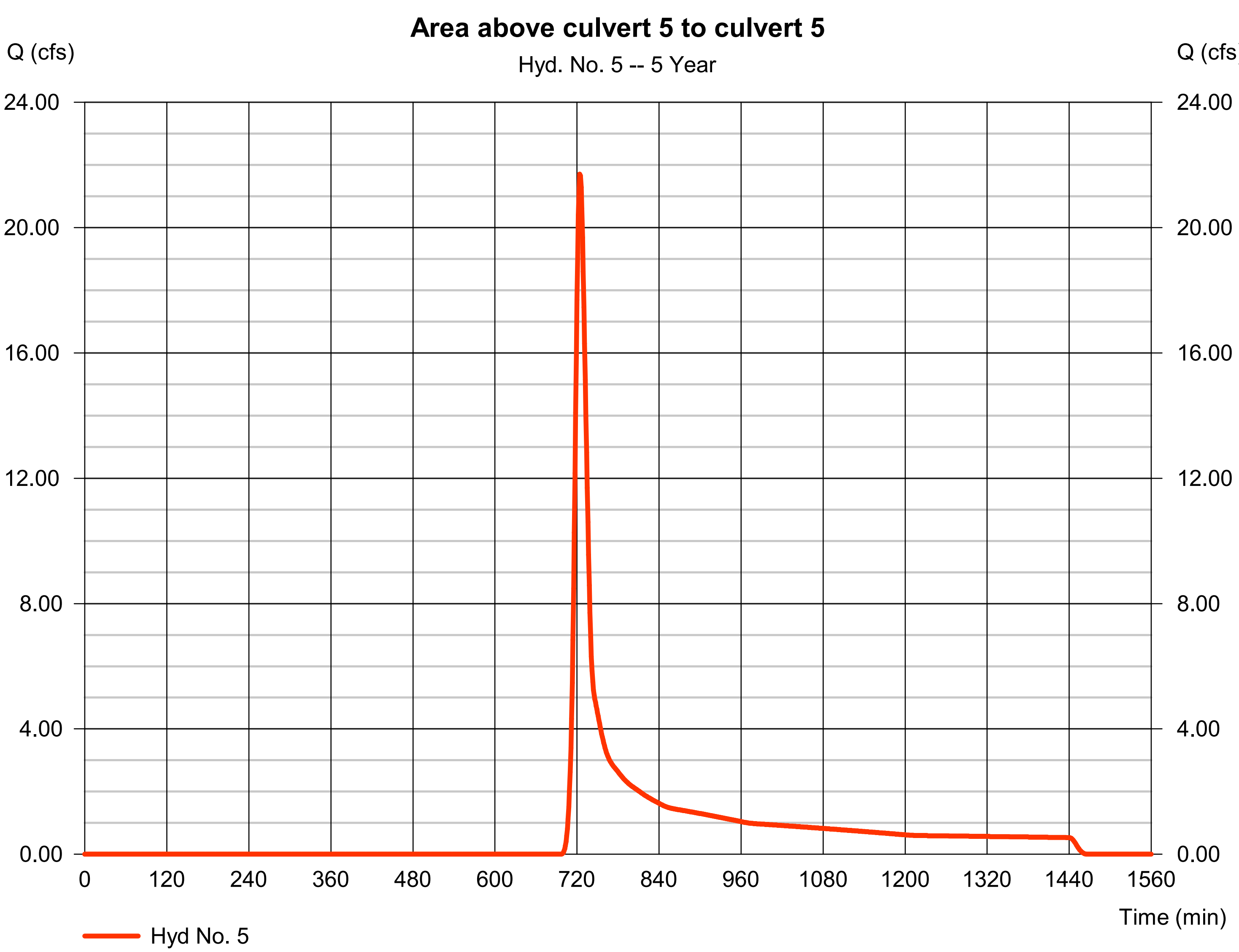
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 21.71 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 71,414 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

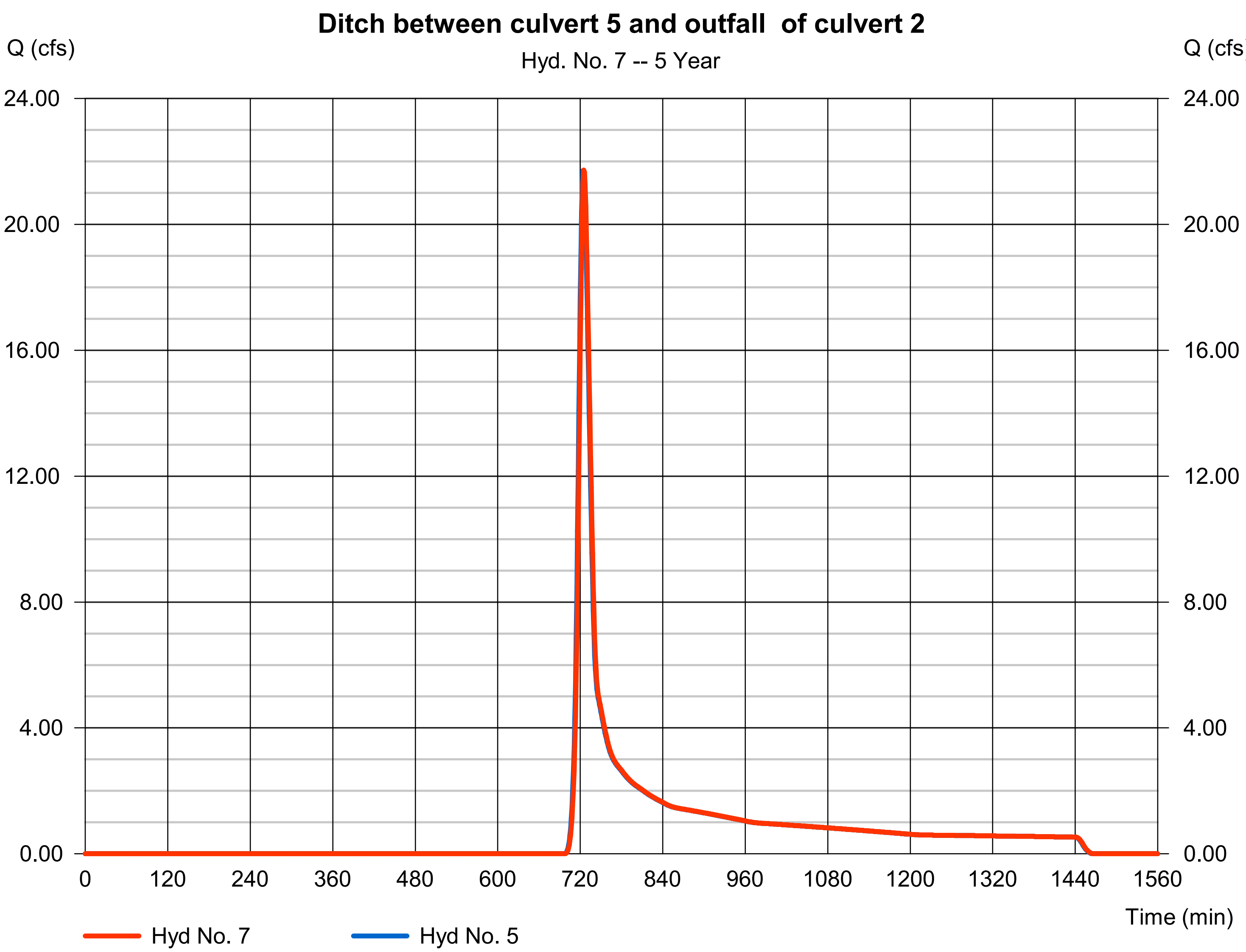
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	=	Reach	Peak discharge	=	21.72 cfs
Storm frequency	=	5 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	71,413 cuft
Inflow hyd. No.	=	5 - Area above culvert 5 to culvert 5	Section type	=	Trapezoidal
Reach length	=	174.0 ft	Channel slope	=	3.8 %
Manning's n	=	0.040	Bottom width	=	3.0 ft
Side slope	=	2.0:1	Max. depth	=	2.0 ft
Rating curve x	=	3.490	Rating curve m	=	1.249
Ave. velocity	=	5.03 ft/s	Routing coeff.	=	1.0398

Modified Att-Kin routing method used.



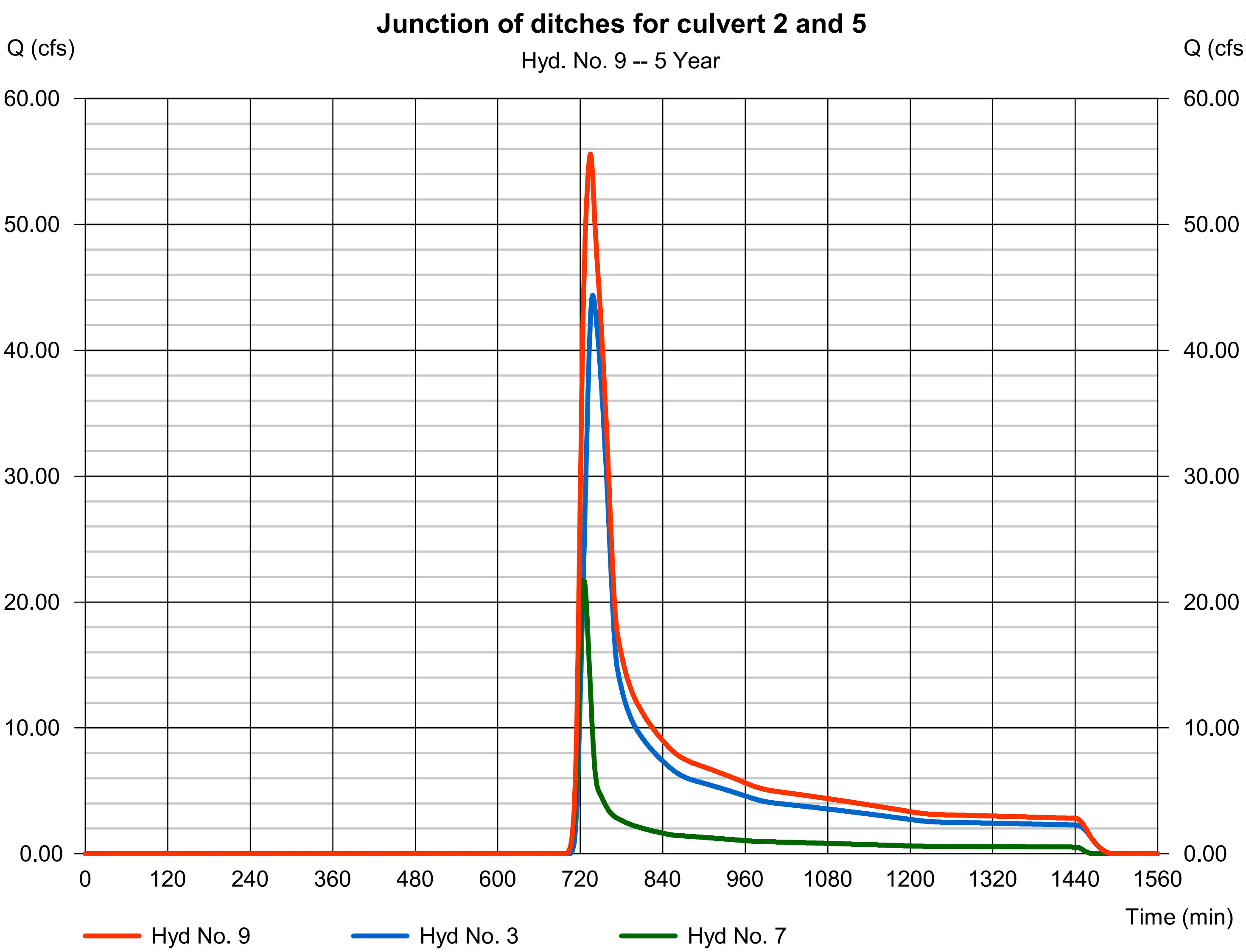
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 55.60 cfs
Storm frequency	= 5 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 344,872 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

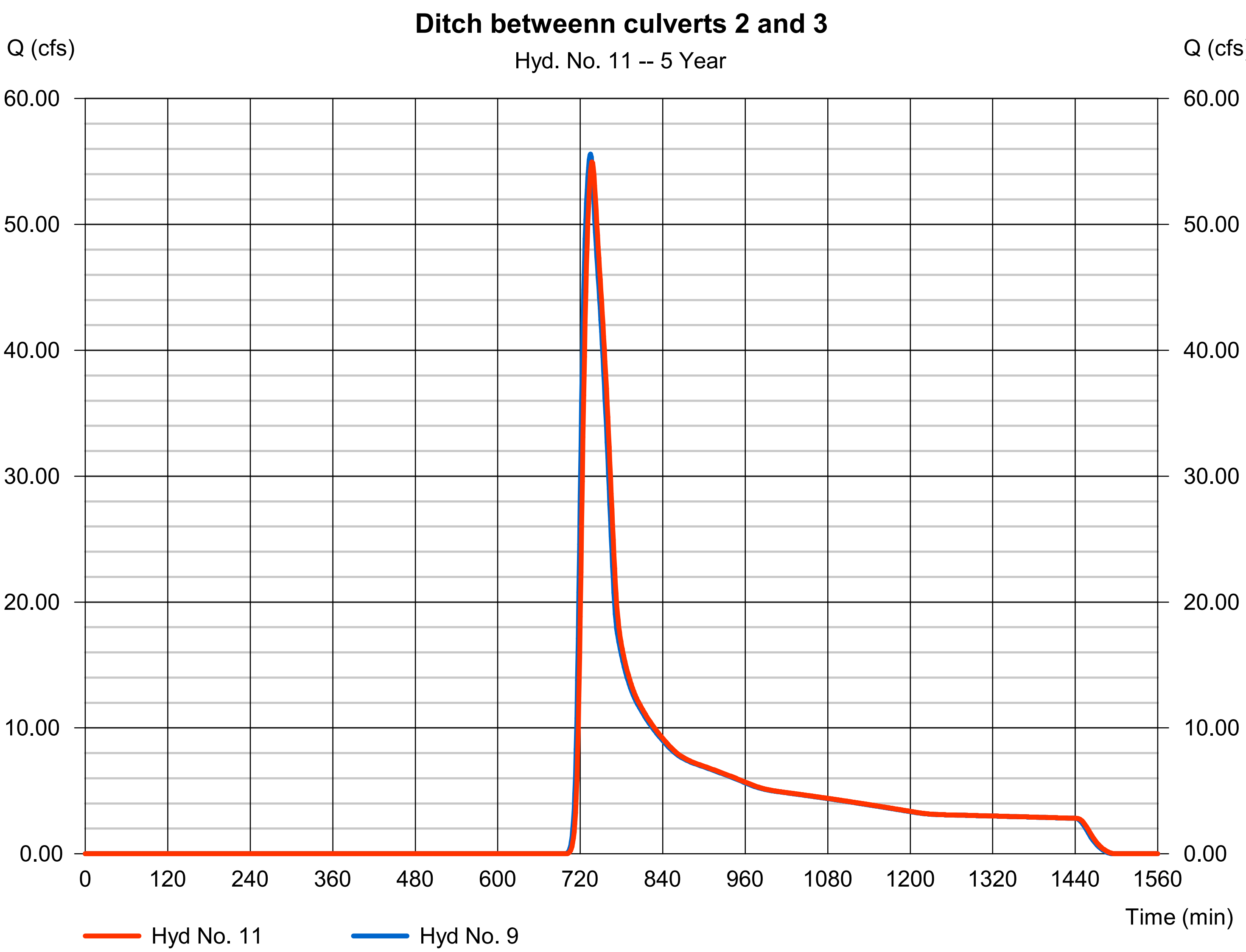
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 54.96 cfs
Storm frequency	= 5 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 344,870 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culvert 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 4.54 ft/s	Routing coeff.	= 0.3661

Modified Att-Kin routing method used.



Hydrograph Report

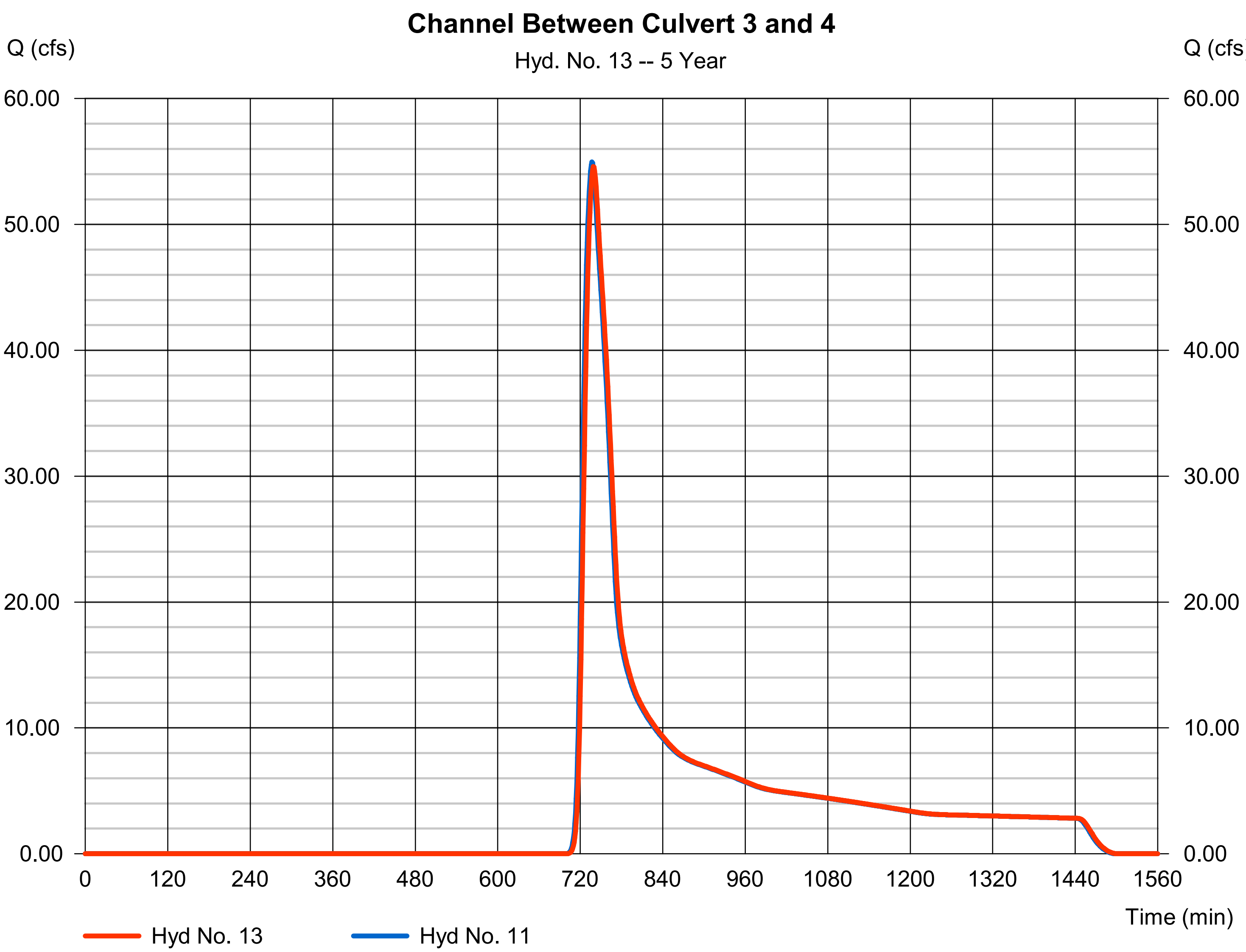
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 54.60 cfs
Storm frequency	= 5 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 344,869 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 3.40 ft/s	Routing coeff.	= 0.4613

Modified Att-Kin routing method used.



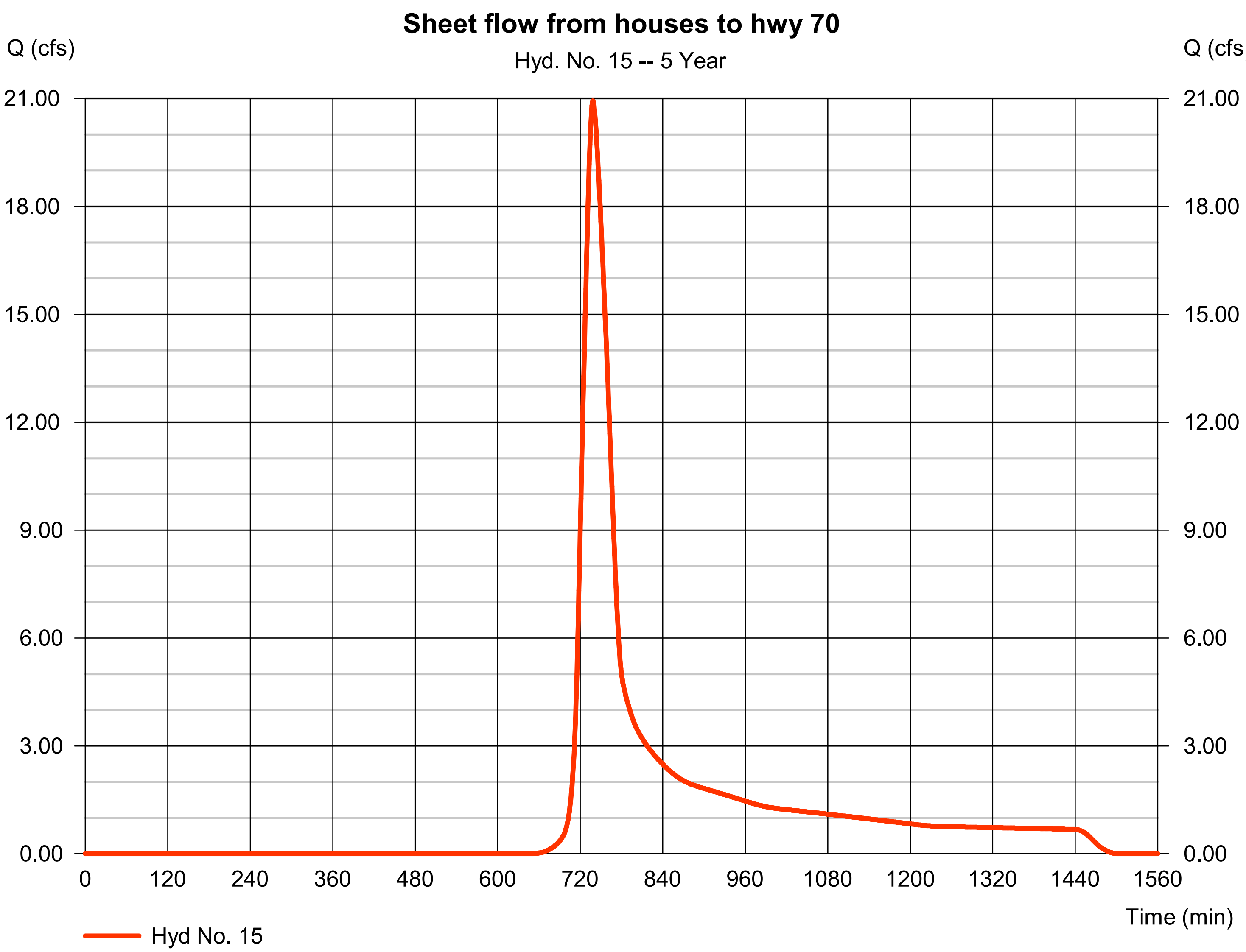
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 15

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 20.93 cfs
Storm frequency	= 5 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 108,627 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.60 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



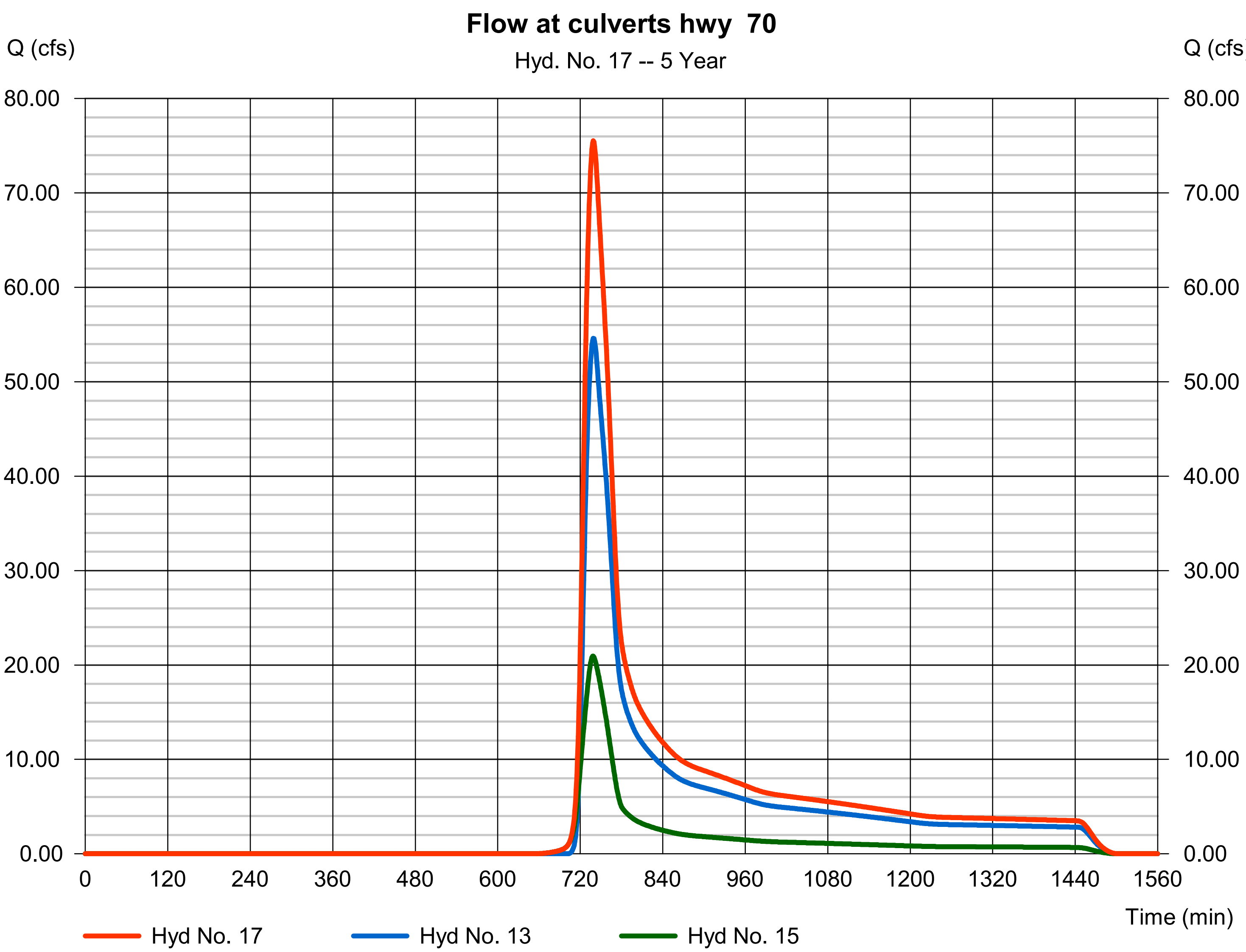
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 17

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 75.52 cfs
Storm frequency	= 5 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 453,496 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 20.330 ac



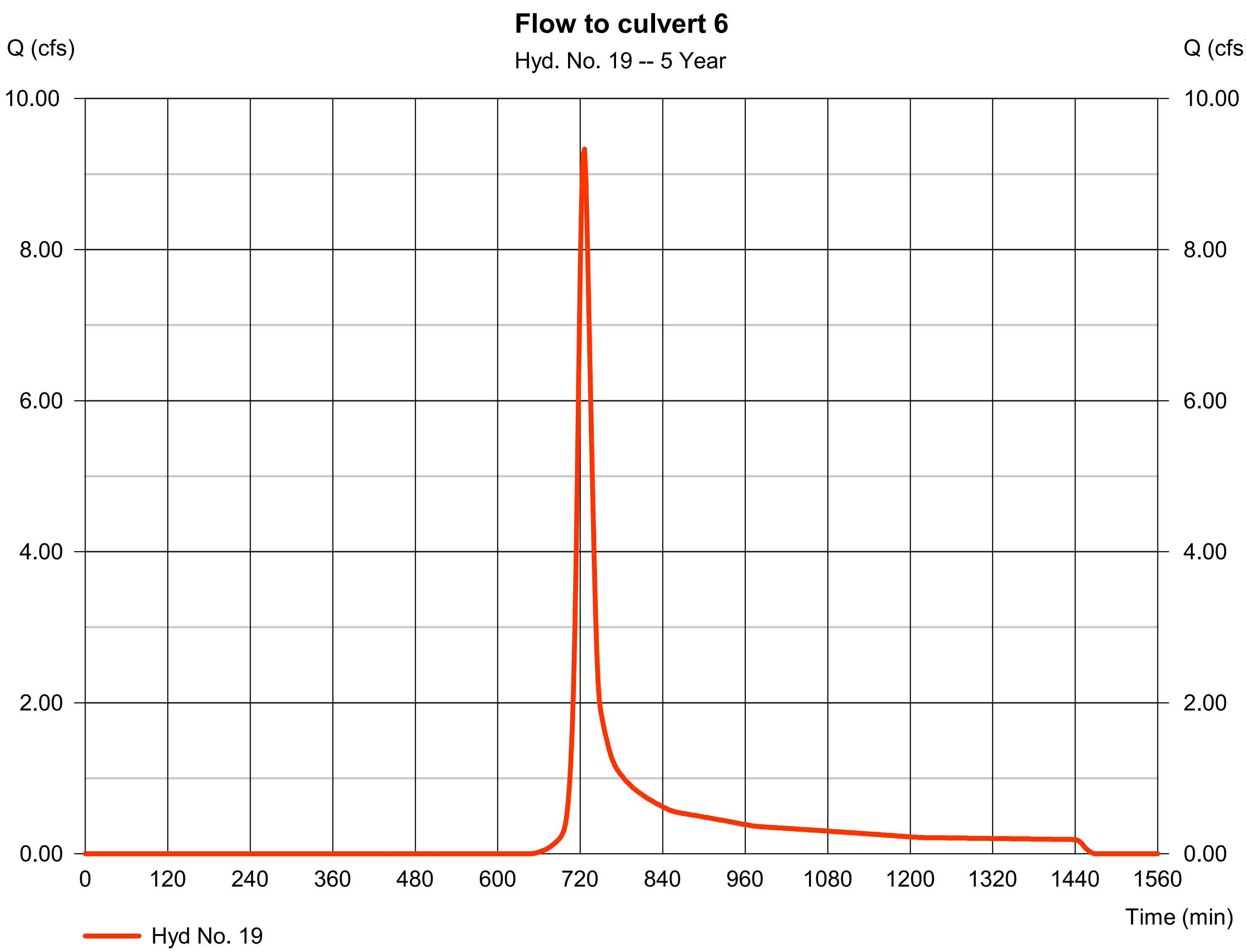
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 19

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 9.331 cfs
Storm frequency	= 5 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 30,563 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	69.68	1	737	385,603	------	------	------	Area Above Hannah Ford leading to
3	Reach	69.68	1	738	385,602	1	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	31.32	1	724	97,360	------	------	------	Area above culvert 5 to culvert 5
7	Reach	31.35	1	725	97,359	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	85.98	1	734	482,962	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	85.22	1	736	482,960	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	84.84	1	738	482,960	11	------	------	Channel Between Culvert 3 and 4
15	SCS Runoff	27.87	1	738	140,815	------	------	------	Sheet flow from houses to hwy 70
17	Combine	112.71	1	738	623,775	13, 15,	------	------	Flow at culverts hwy 70
19	SCS Runoff	12.30	2	726	39,619	------	------	------	Flow to culvert 6

Hydrograph Report

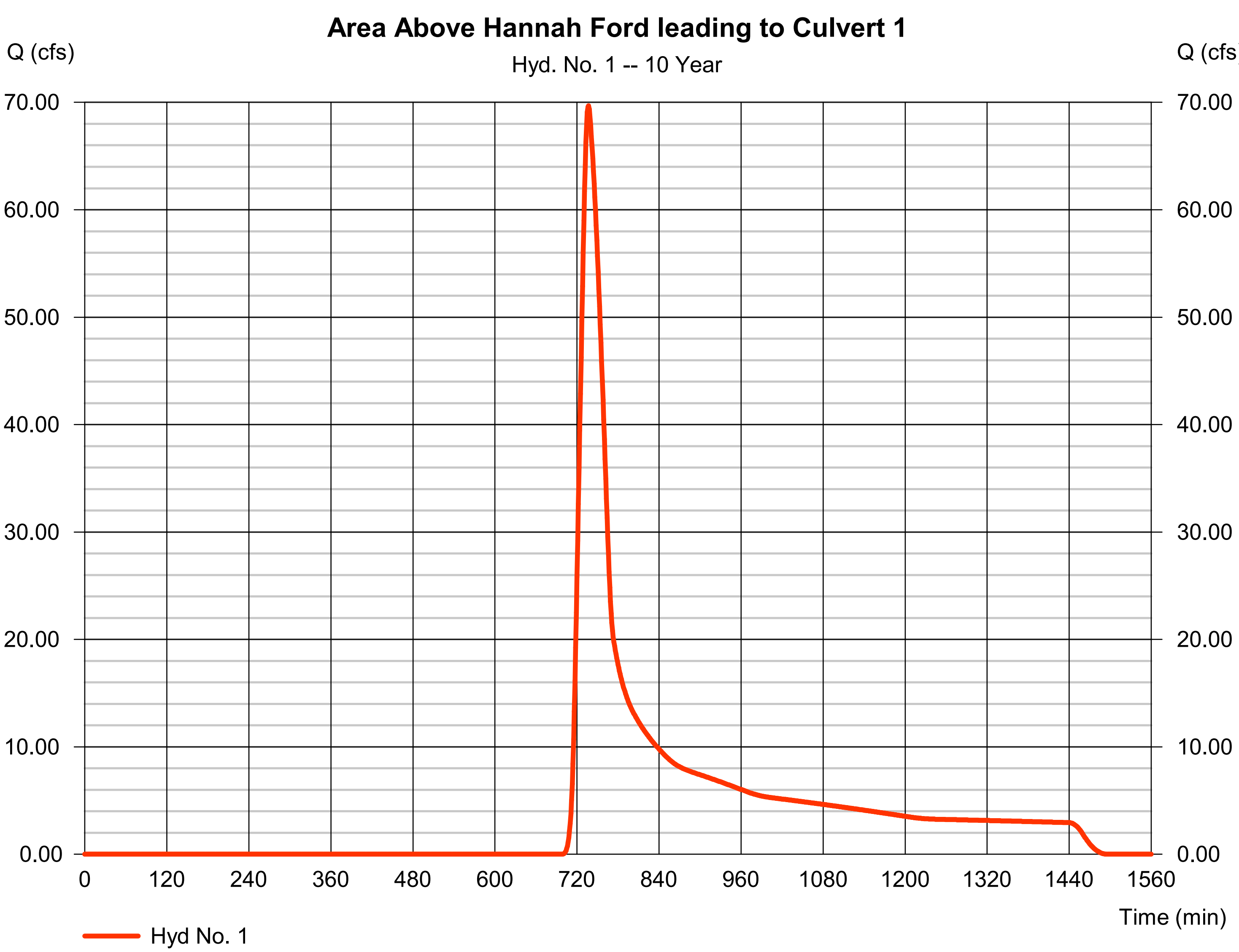
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 69.68 cfs
Storm frequency	= 10 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 385,603 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	=	Reach	Peak discharge	=	69.68 cfs
Storm frequency	=	10 yrs	Time to peak	=	738 min
Time interval	=	1 min	Hyd. volume	=	385,602 cuft
Inflow hyd. No.	=	1 - Area Above Hannah Ford leading to Culvert 1	Section type	=	Trapezoidal
Reach length	=	118.0 ft	Channel slope	=	1.8 %
Manning's n	=	0.030	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	5.0 ft
Rating curve x	=	3.202	Rating curve m	=	1.279
Ave. velocity	=	6.27 ft/s	Routing coeff.	=	1.3418

Modified Att-Kin routing method used.

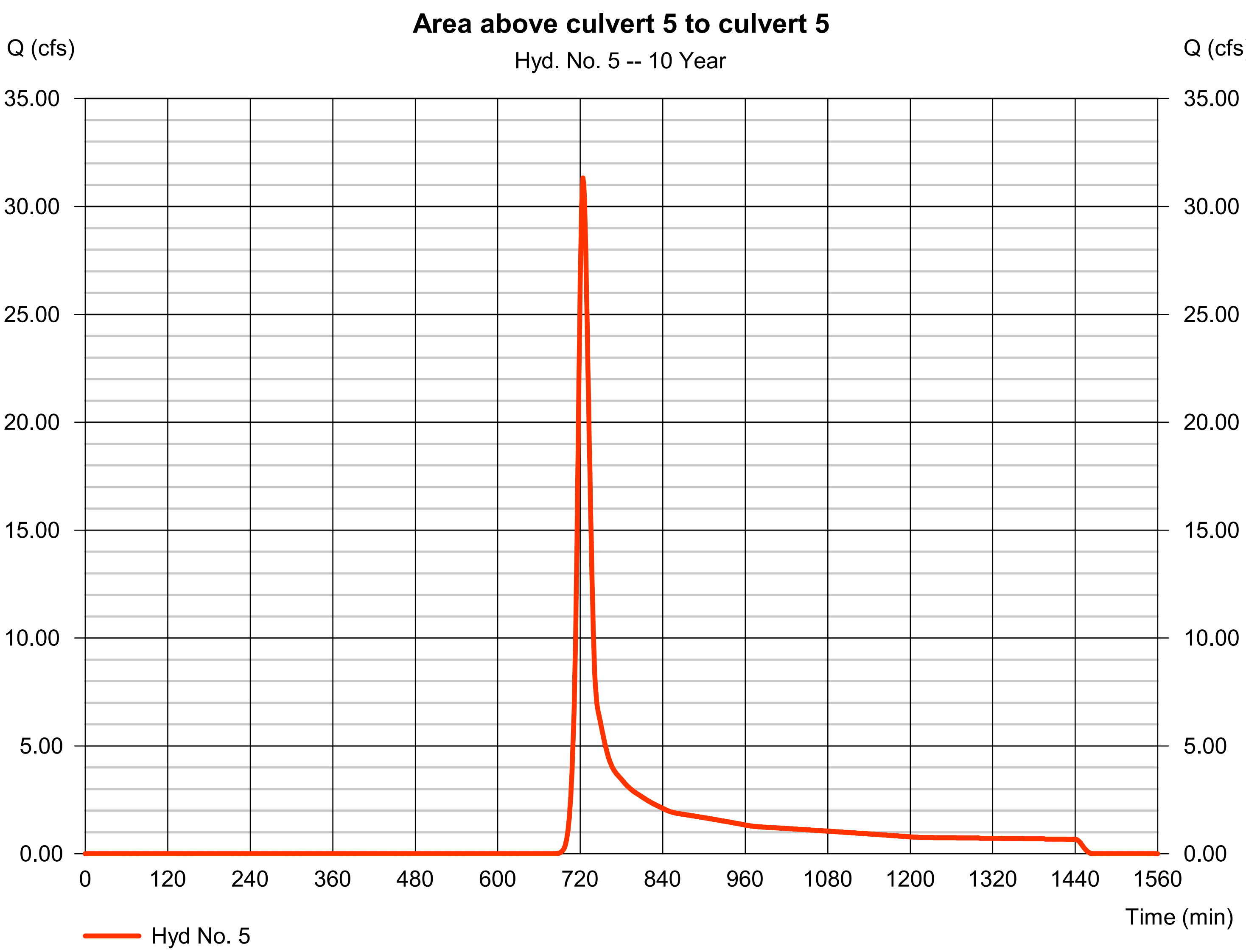
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 31.32 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 97,360 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 7

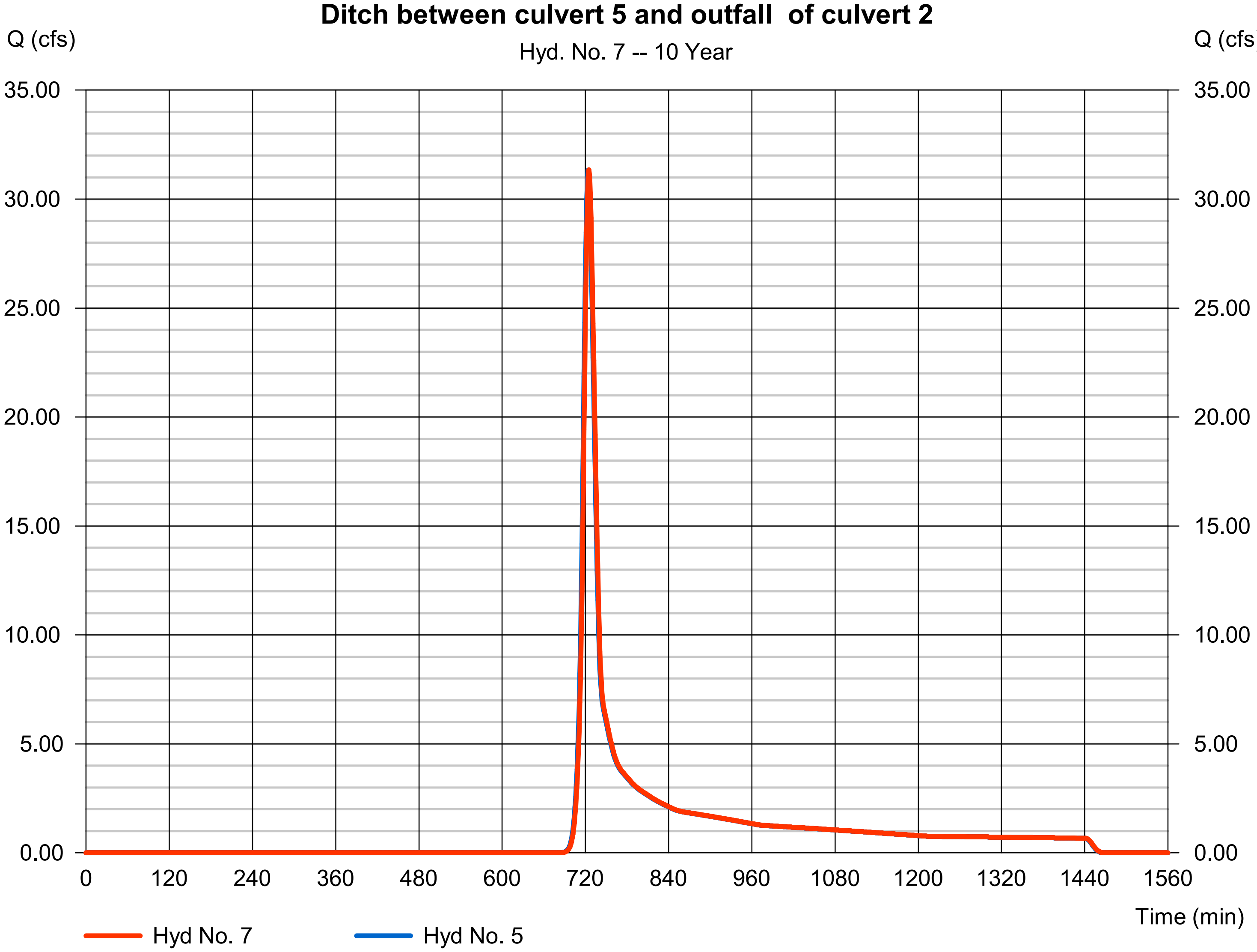
Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 31.35 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 97,359 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 5.41 ft/s	Routing coeff.	= 1.0762

Modified Att-Kin routing method used.

Ditch between culvert 5 and outfall of culvert 2

Hyd. No. 7 -- 10 Year



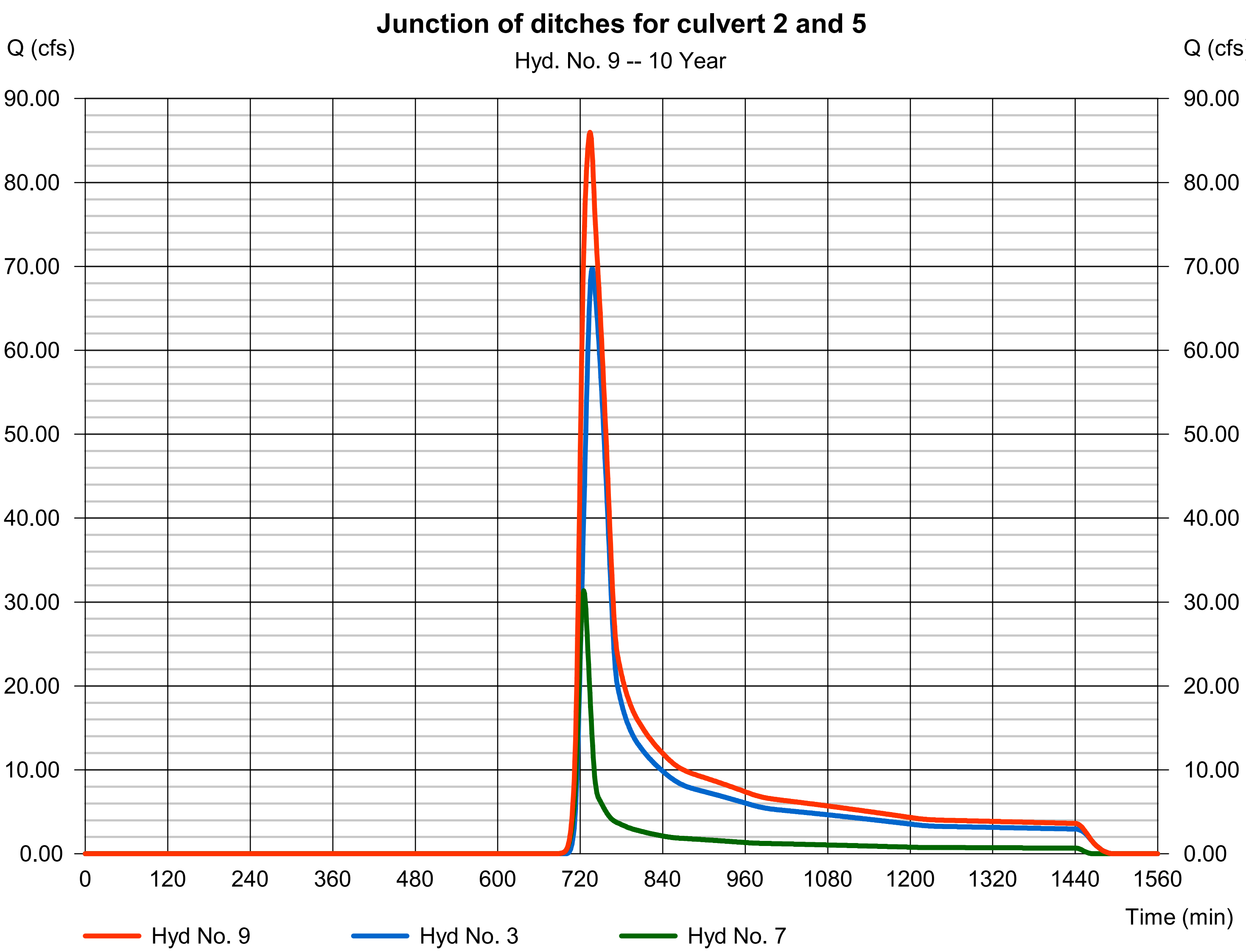
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 85.98 cfs
Storm frequency	= 10 yrs	Time to peak	= 734 min
Time interval	= 1 min	Hyd. volume	= 482,962 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

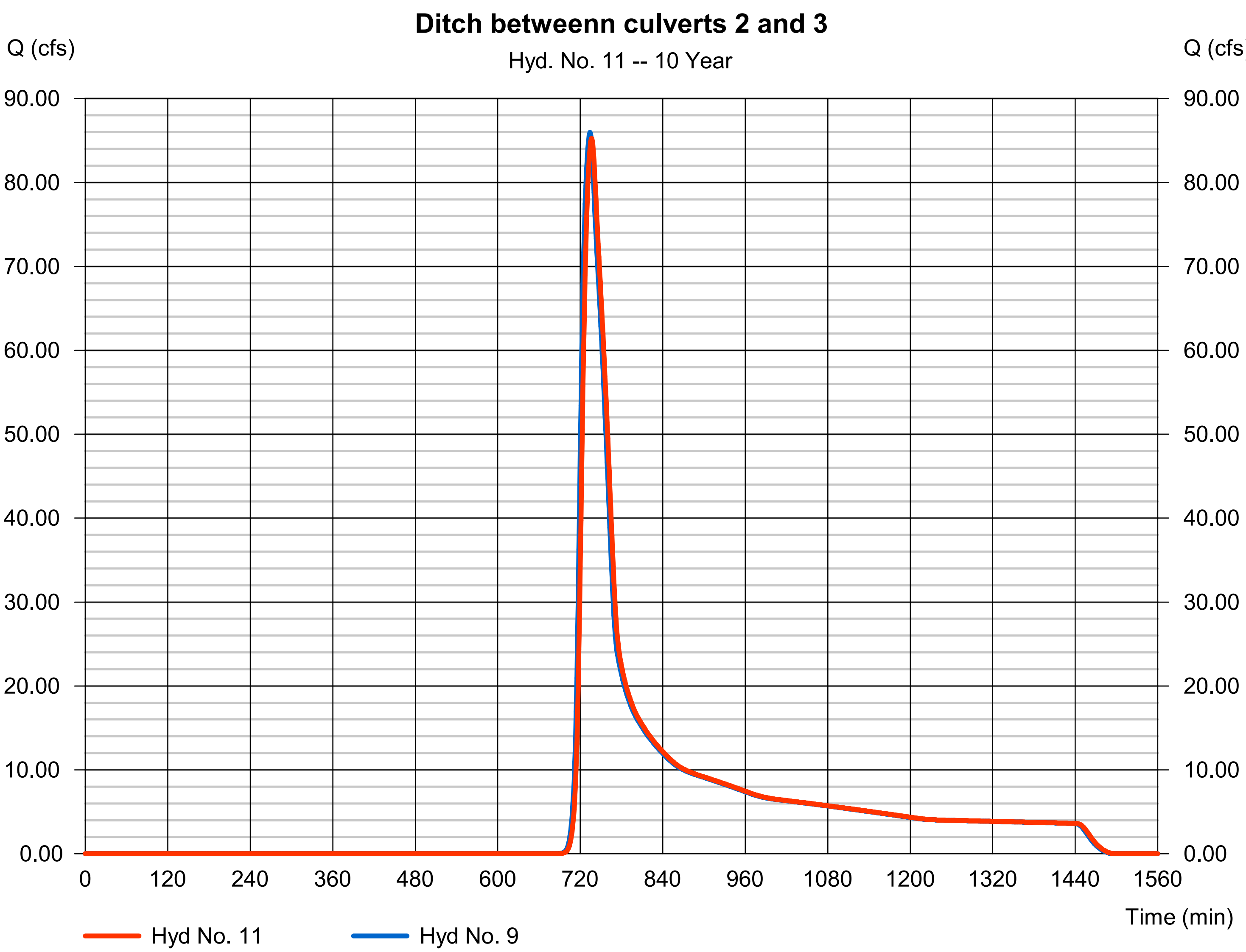
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 85.22 cfs
Storm frequency	= 10 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 482,960 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 5.07 ft/s	Routing coeff.	= 0.4005

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 13

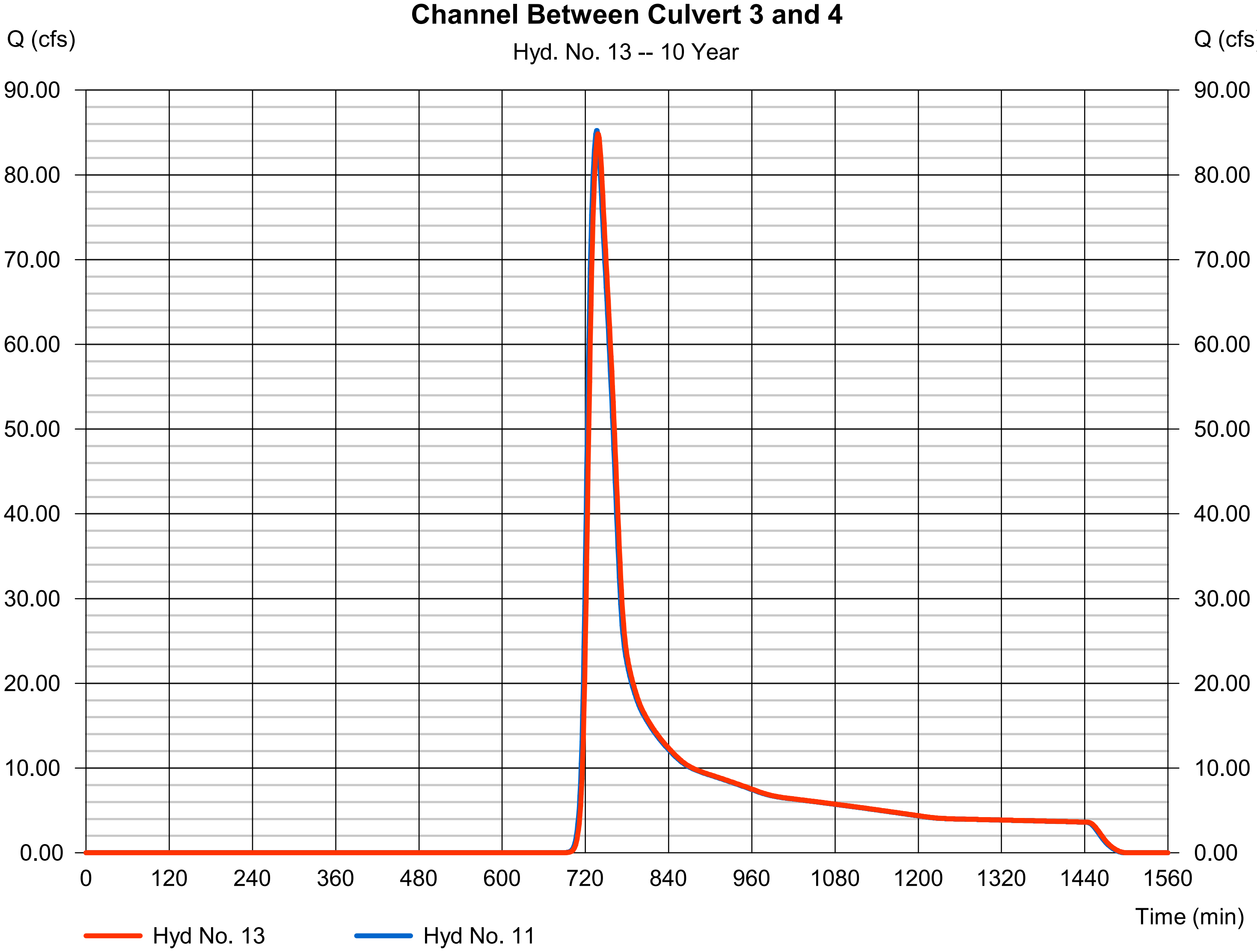
Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 84.84 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 482,960 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 3.79 ft/s	Routing coeff.	= 0.5002

Modified Att-Kin routing method used.

Channel Between Culvert 3 and 4

Hyd. No. 13 -- 10 Year



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 15

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 27.87 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 140,815 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.60 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

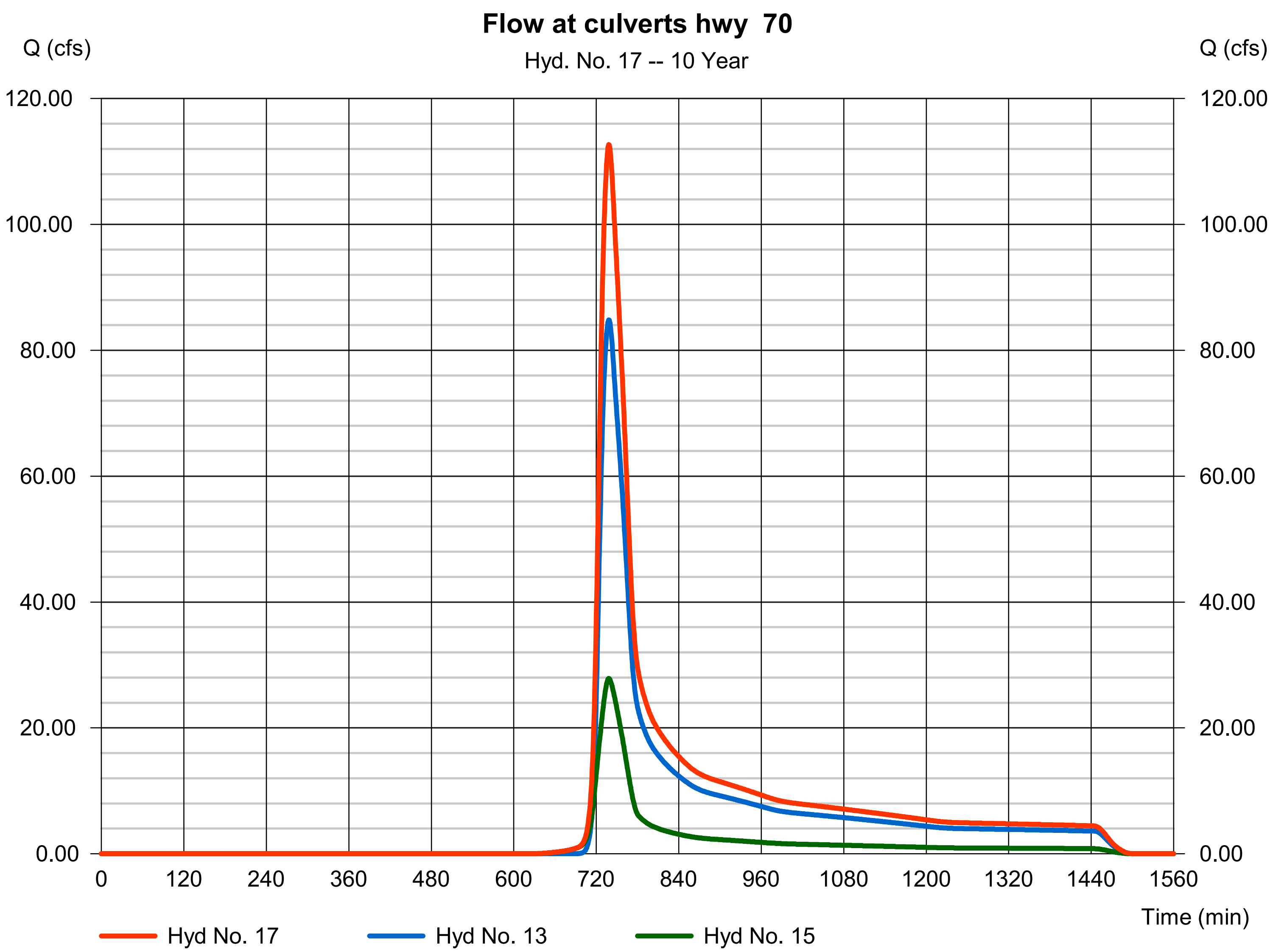
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 17

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 112.71 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 623,775 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 20.330 ac



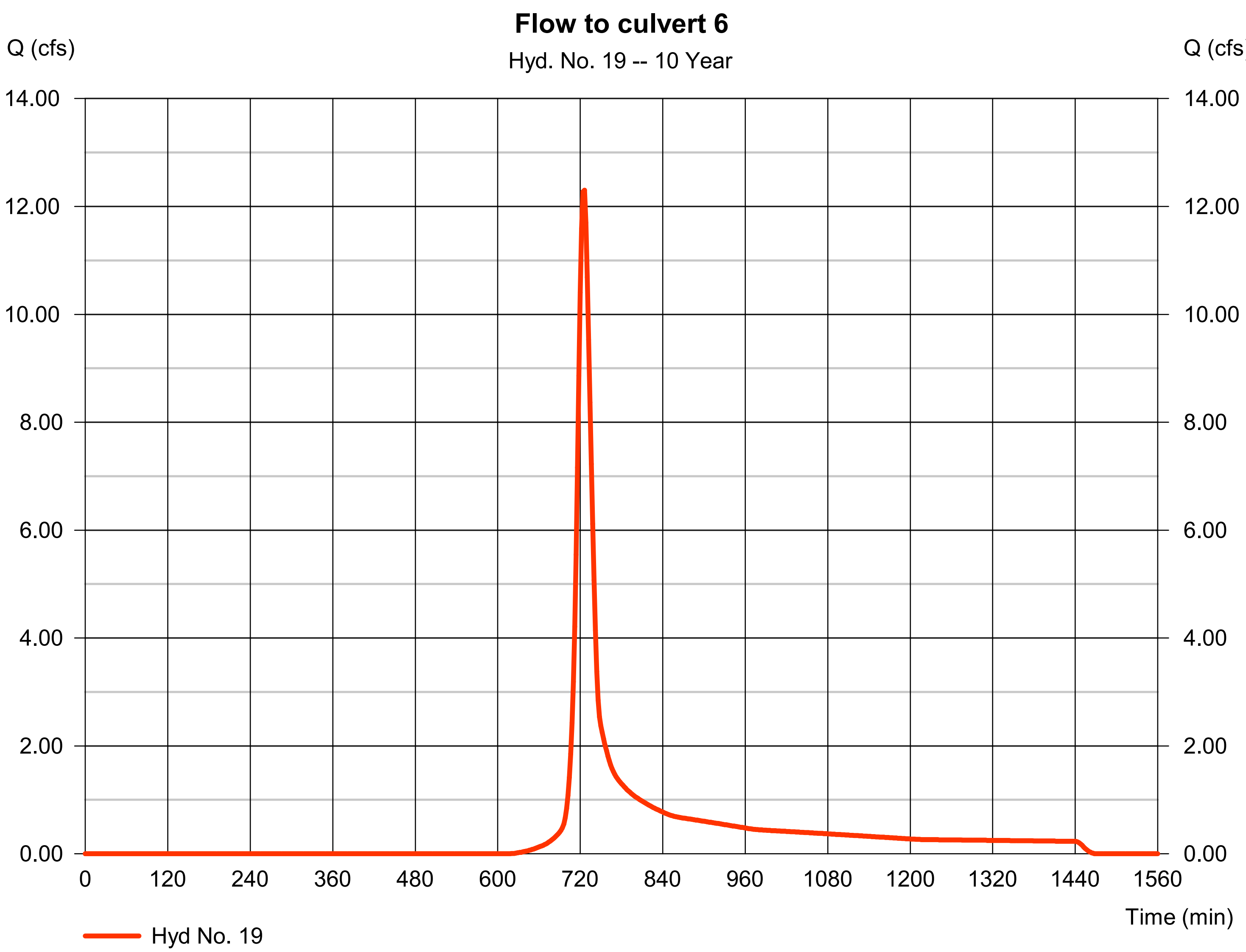
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 | Thursday, 03 / 2 / 2017

Hyd. No. 19

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 12.30 cfs
Storm frequency	= 10 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 39,619 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	112.65	1	736	568,777	------	------	------	Area Above Hannah Ford leading to
3	Reach	112.65	1	737	568,777	1	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	46.54	1	724	138,852	------	------	------	Area above culvert 5 to culvert 5
7	Reach	46.56	1	725	138,852	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	137.16	1	734	707,628	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	136.38	1	736	707,627	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	135.91	1	737	707,626	11	------	------	Channel Between Culvert 3 and 4
15	SCS Runoff	38.53	1	738	190,584	------	------	------	Sheet flow from houses to hwy 70
17	Combine	174.39	1	738	898,210	13, 15,	------	------	Flow at culverts hwy 70
19	SCS Runoff	16.91	2	724	53,622	------	------	------	Flow to culvert 6

Hydrograph Report

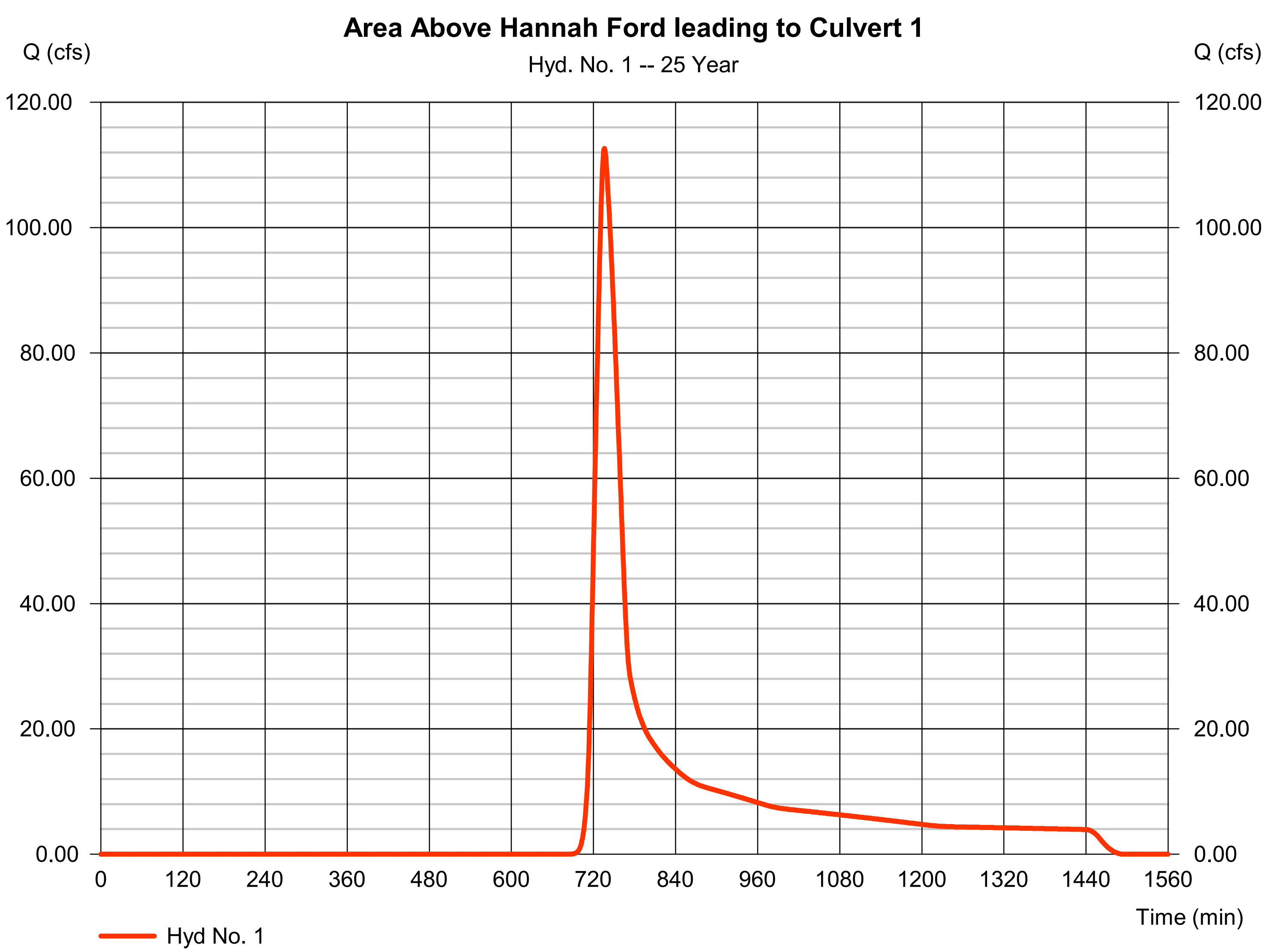
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 112.65 cfs
Storm frequency	= 25 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 568,777 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

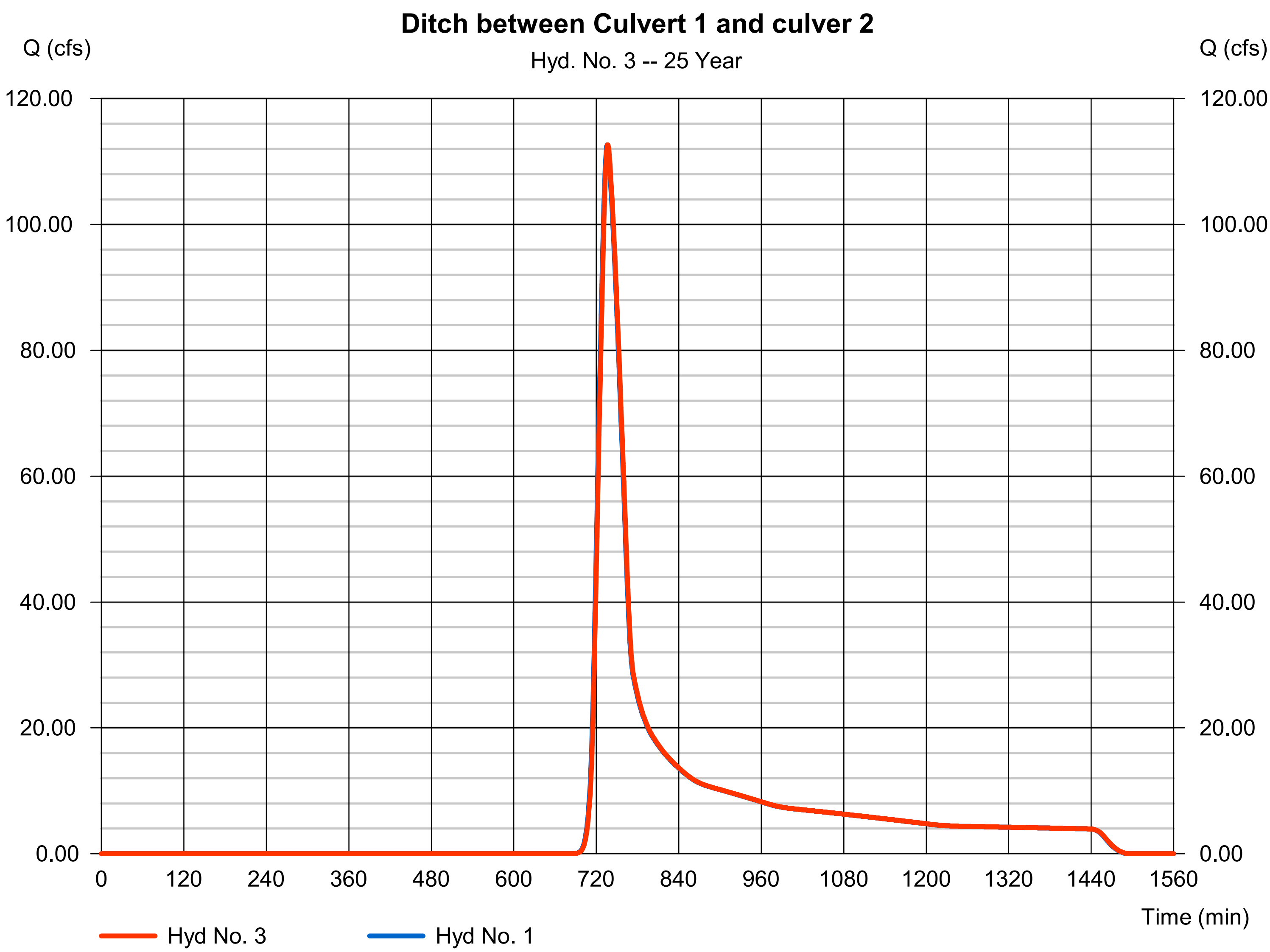
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 112.65 cfs
Storm frequency	= 25 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 568,777 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 6.96 ft/s	Routing coeff.	= 1.3872

Modified Att-Kin routing method used.



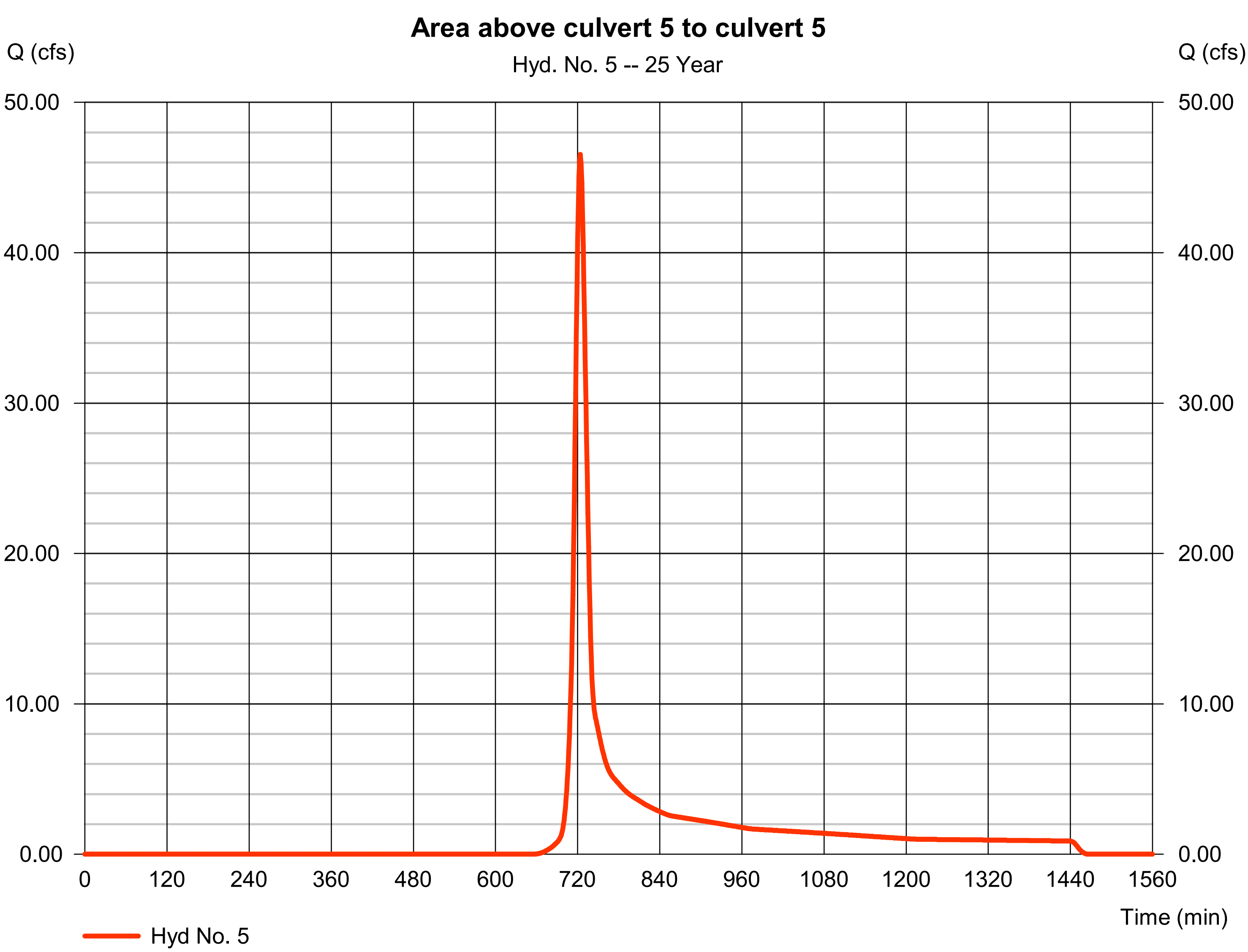
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 46.54 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 138,852 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

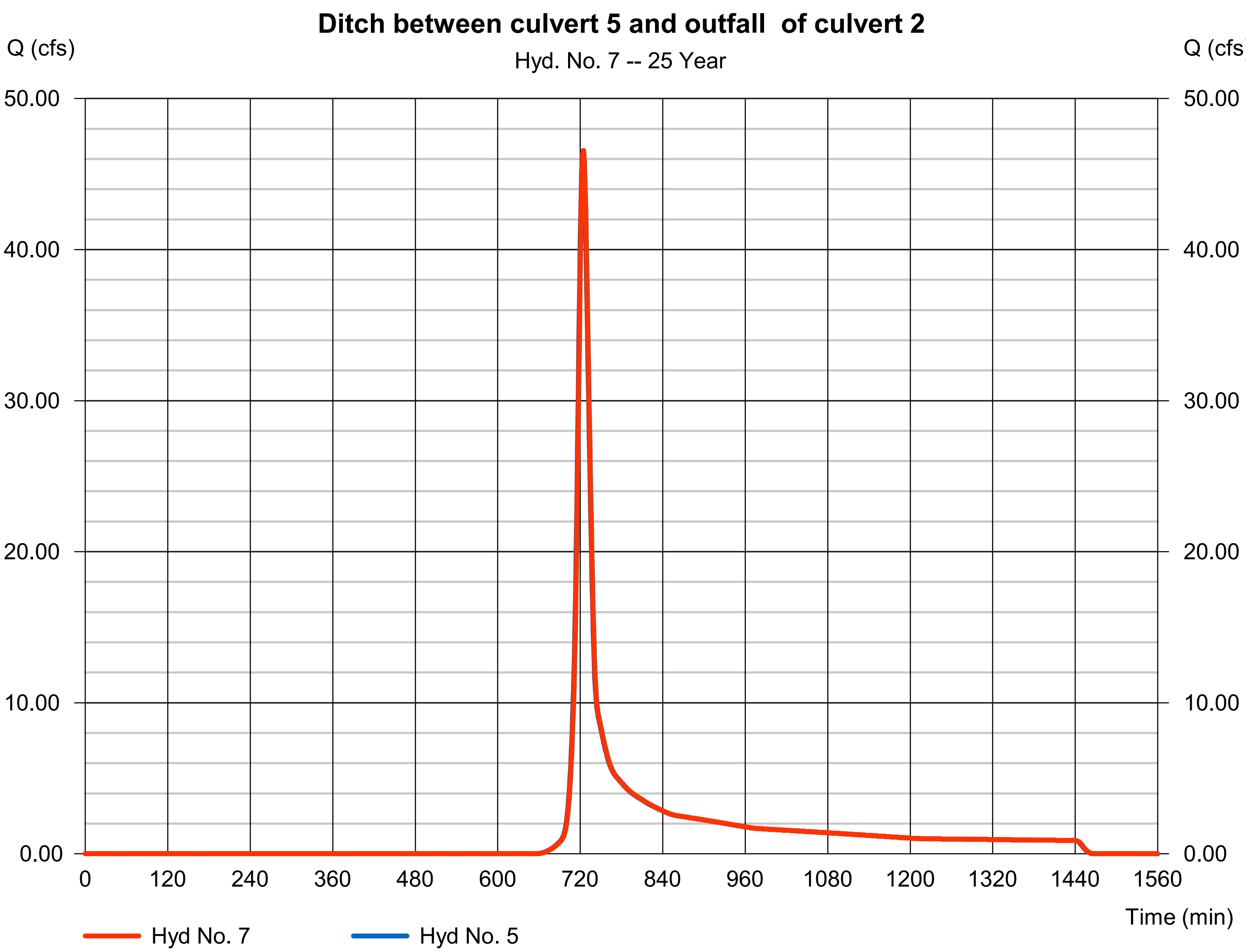
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 | Thursday, 03 / 2 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 46.56 cfs
Storm frequency	= 25 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 138,852 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 5.85 ft/s	Routing coeff.	= 1.1154

Modified Att-Kin routing method used.



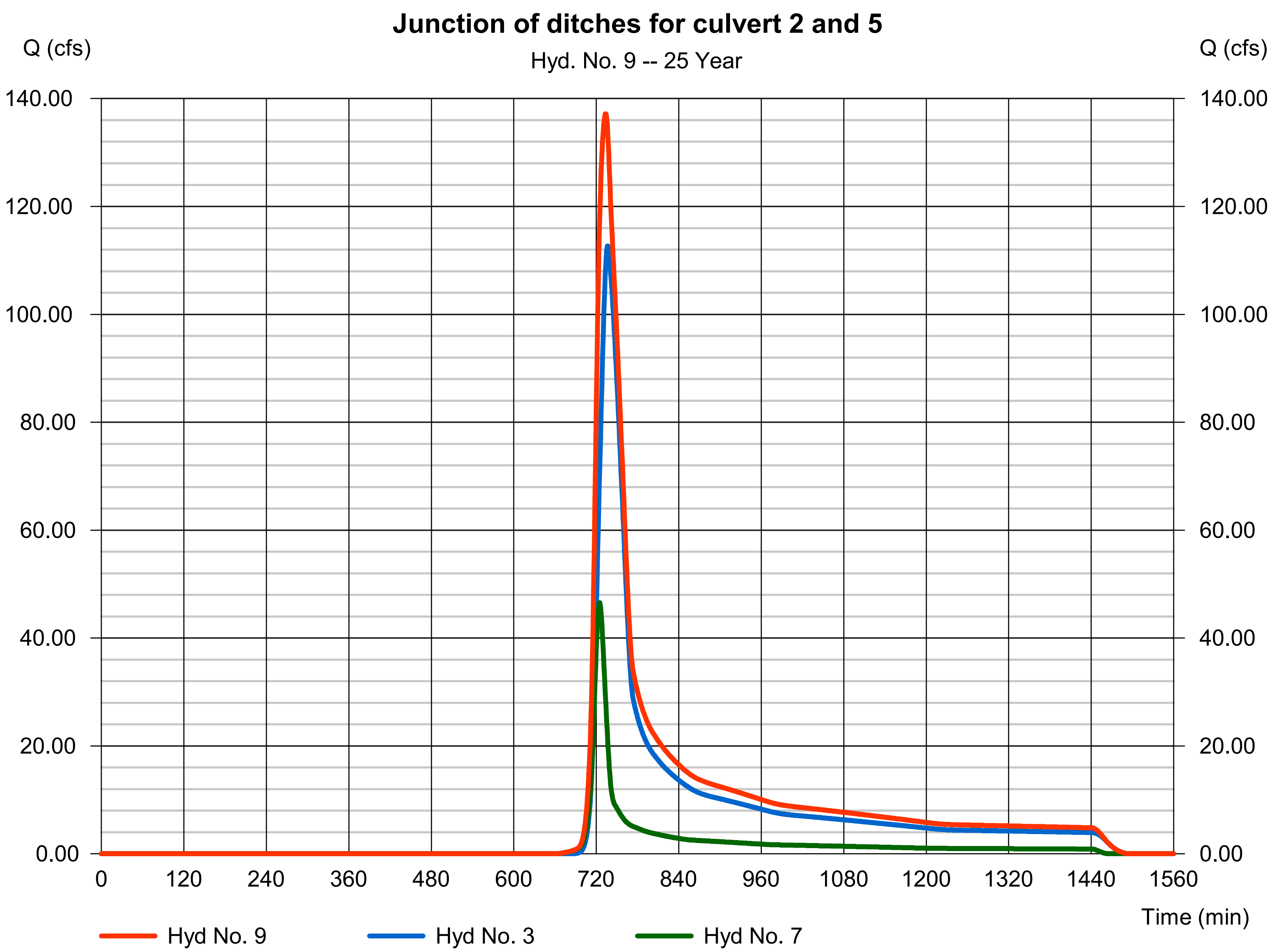
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 137.16 cfs
Storm frequency	= 25 yrs	Time to peak	= 734 min
Time interval	= 1 min	Hyd. volume	= 707,628 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

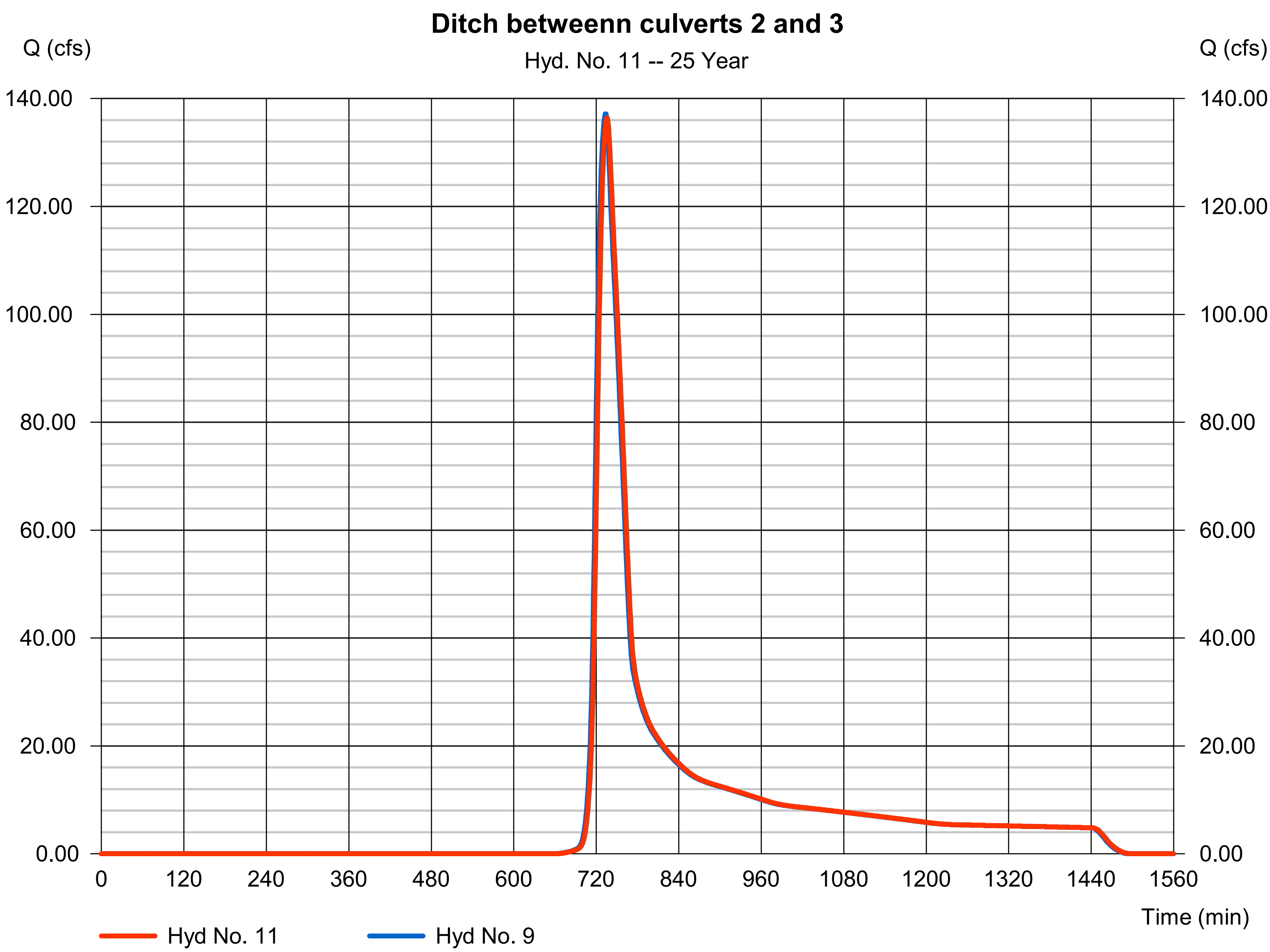
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 136.38 cfs
Storm frequency	= 25 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 707,627 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 5.71 ft/s	Routing coeff.	= 0.4399

Modified Att-Kin routing method used.



Hydrograph Report

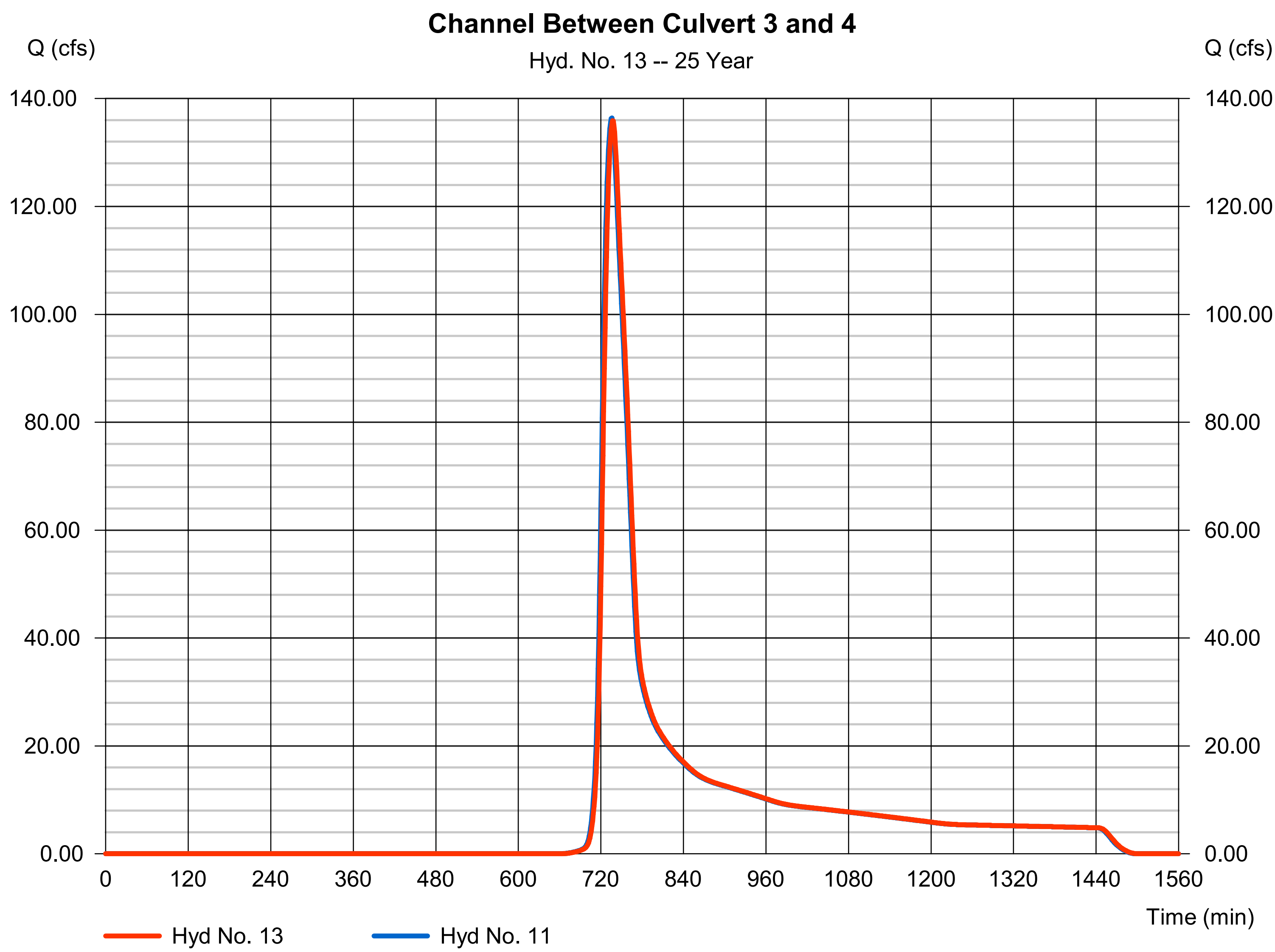
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 135.91 cfs
Storm frequency	= 25 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 707,626 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 4.25 ft/s	Routing coeff.	= 0.5443

Modified Att-Kin routing method used.



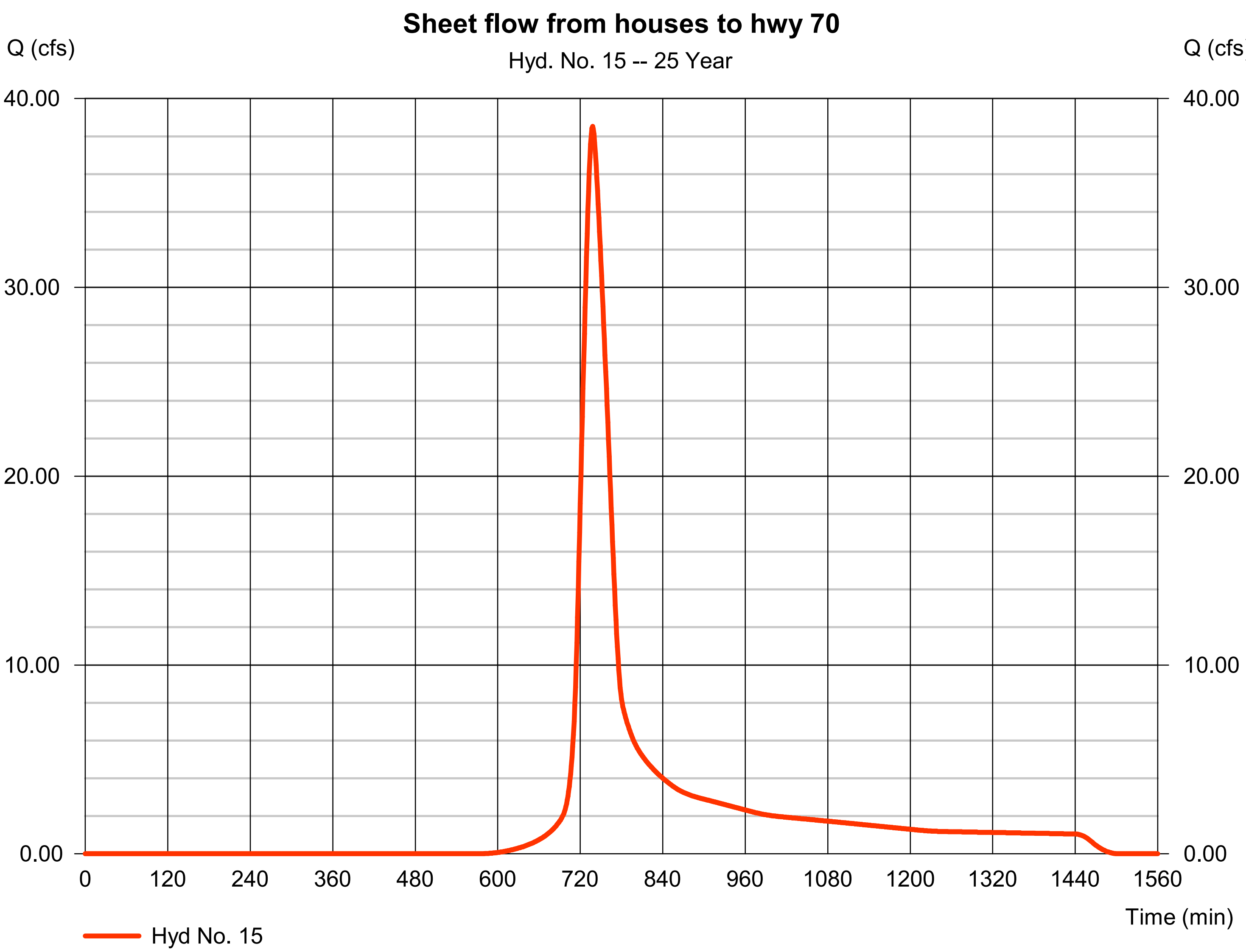
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 15

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 38.53 cfs
Storm frequency	= 25 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 190,584 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.60 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



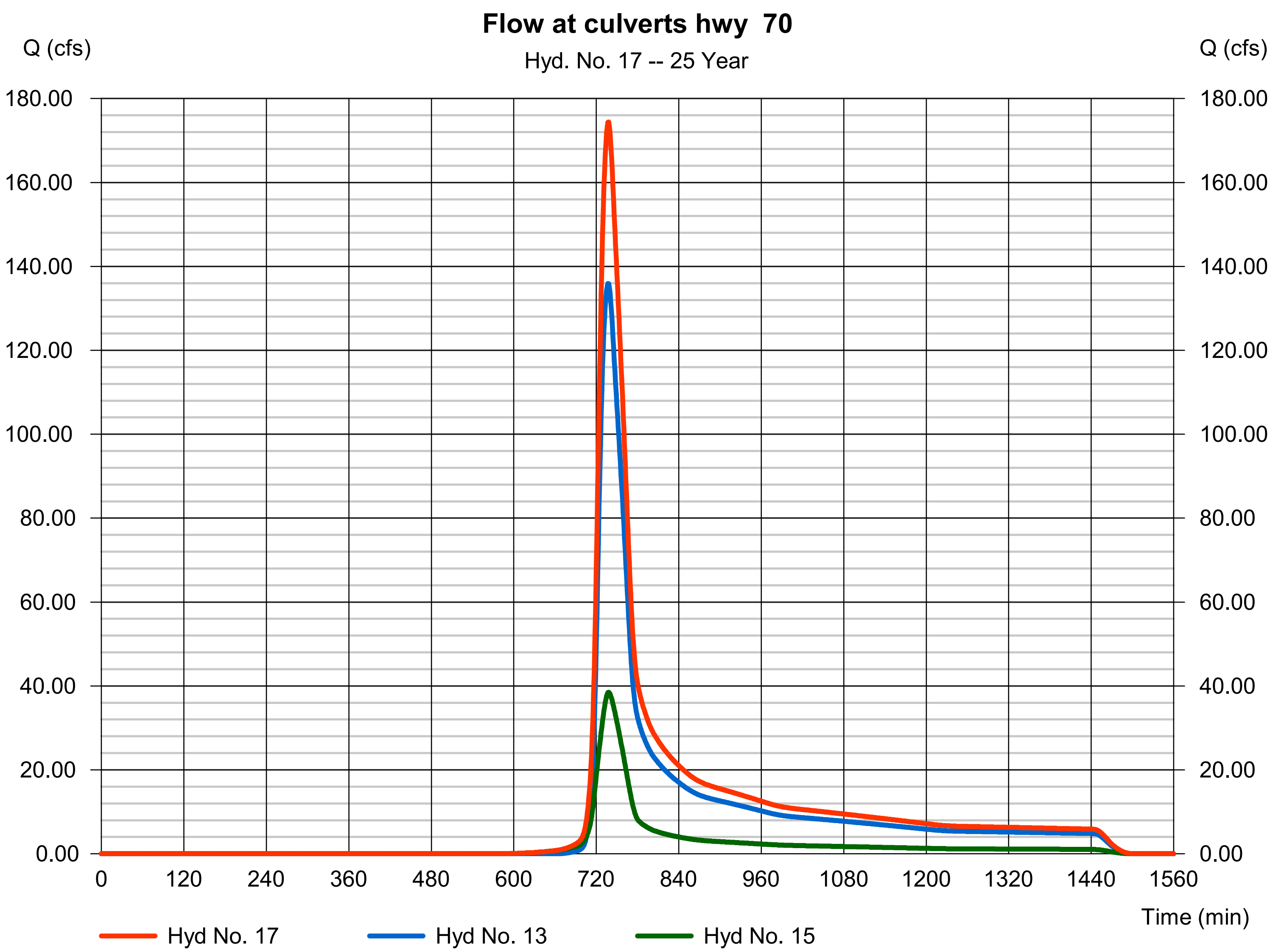
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 17

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 174.39 cfs
Storm frequency	= 25 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 898,210 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 20.330 ac



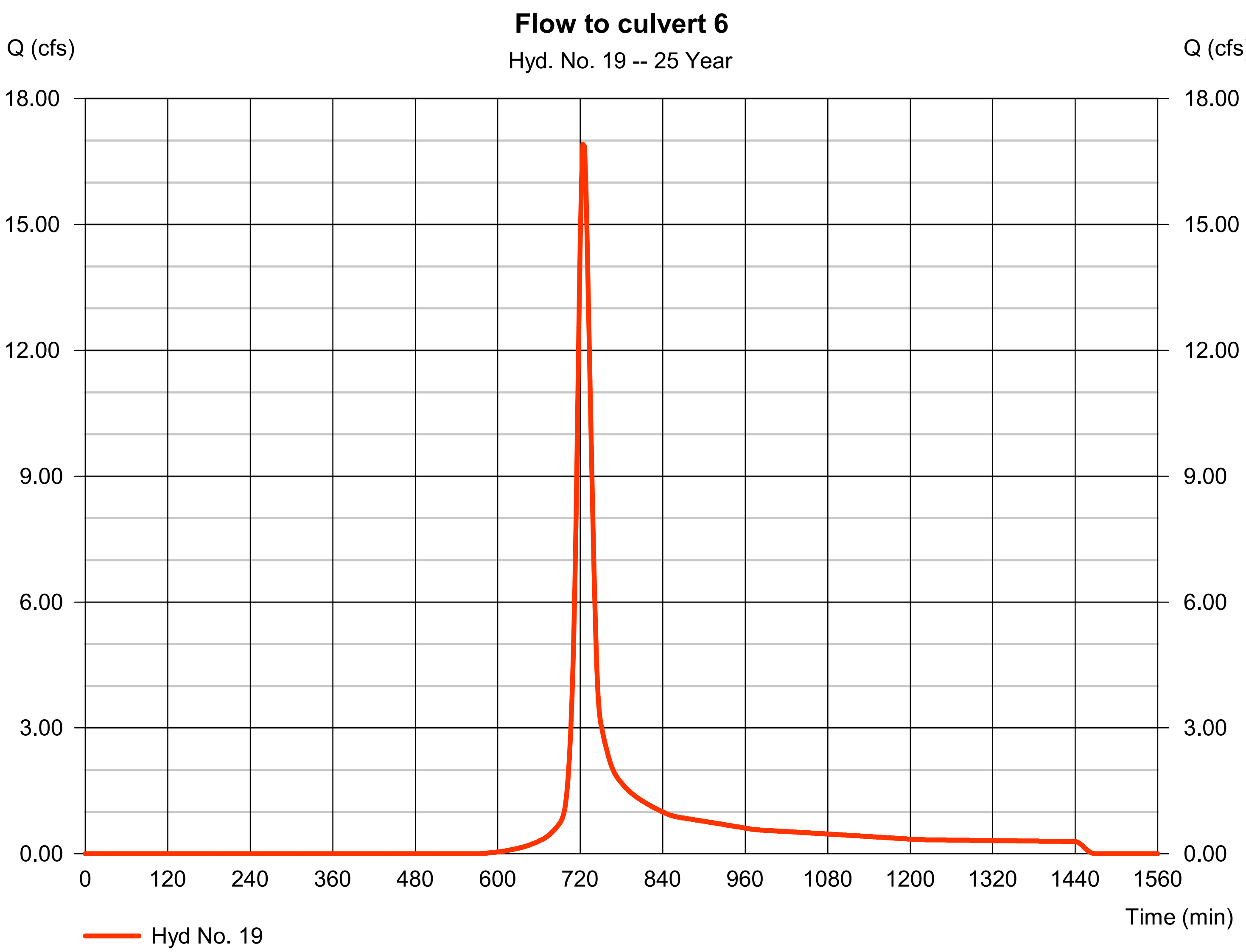
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 19

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 16.91 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 53,622 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	150.27	1	736	728,353	------	------	------	Area Above Hannah Ford leading to
3	Reach	150.52	1	736	728,354	1	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	59.46	1	724	174,409	------	------	------	Area above culvert 5 to culvert 5
7	Reach	59.47	1	725	174,409	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	182.11	1	733	902,763	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	181.23	1	735	902,761	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	180.75	1	737	902,761	11	------	------	Channel Between Culvert 3 and 4
15	SCS Runoff	47.37	1	738	232,111	------	------	------	Sheet flow from houses to hwy 70
17	Combine	228.03	1	737	1,134,870	13, 15,	------	------	Flow at culverts hwy 70
19	SCS Runoff	20.75	2	724	65,306	------	------	------	Flow to culvert 6

Hydrograph Report

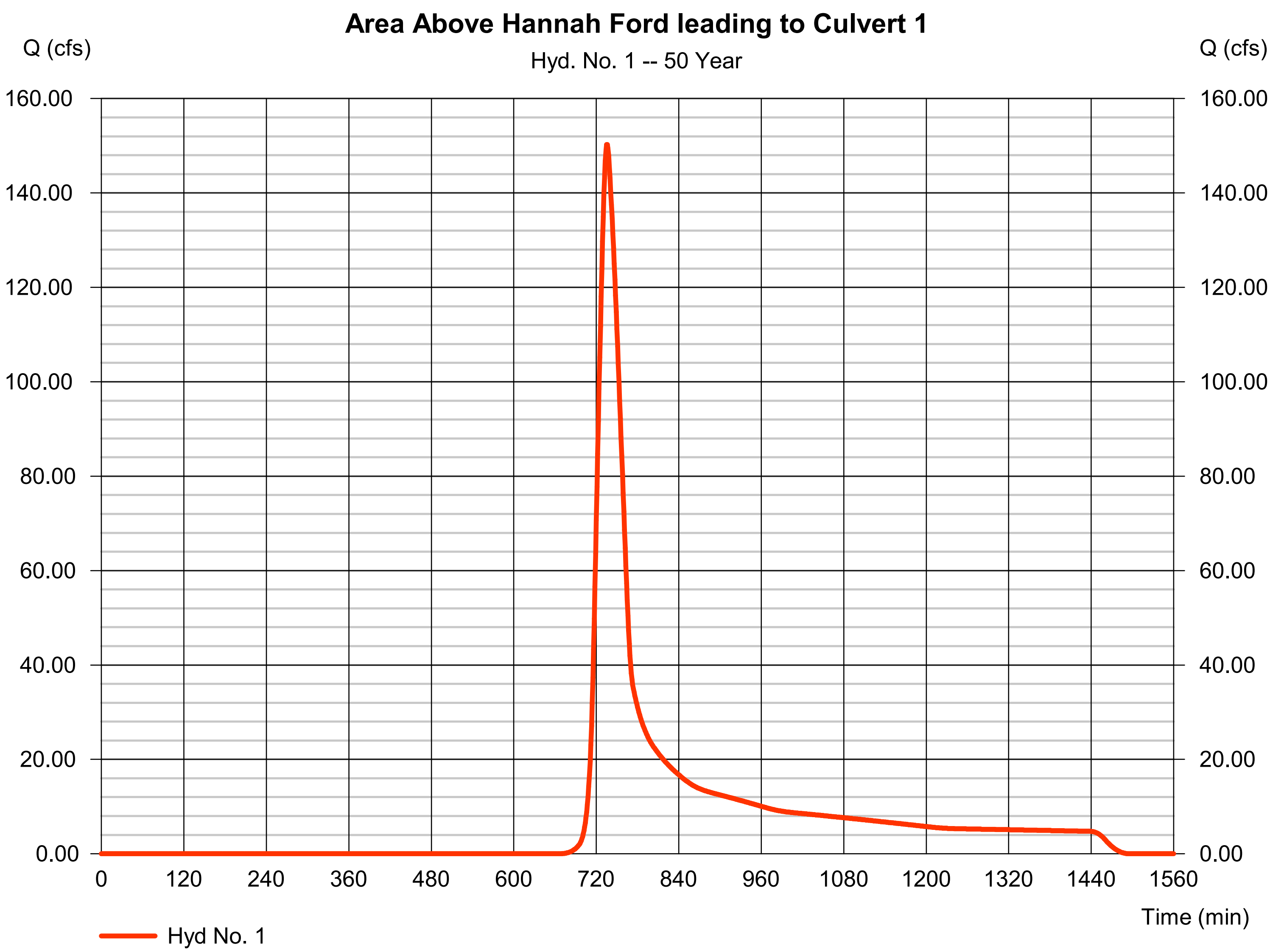
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 150.27 cfs
Storm frequency	= 50 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 728,353 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

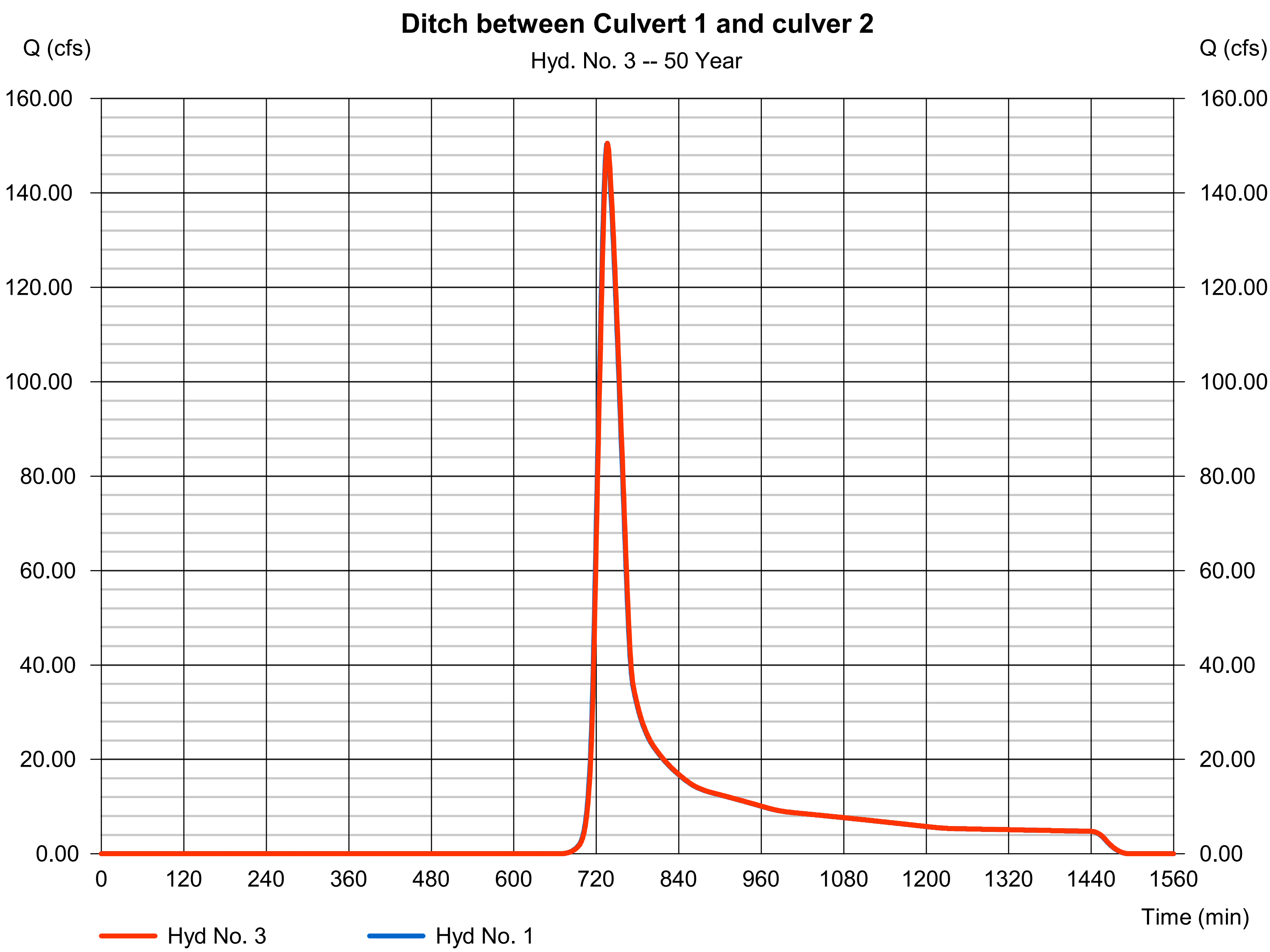
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 150.52 cfs
Storm frequency	= 50 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 728,354 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 7.41 ft/s	Routing coeff.	= 1.4136

Modified Att-Kin routing method used.



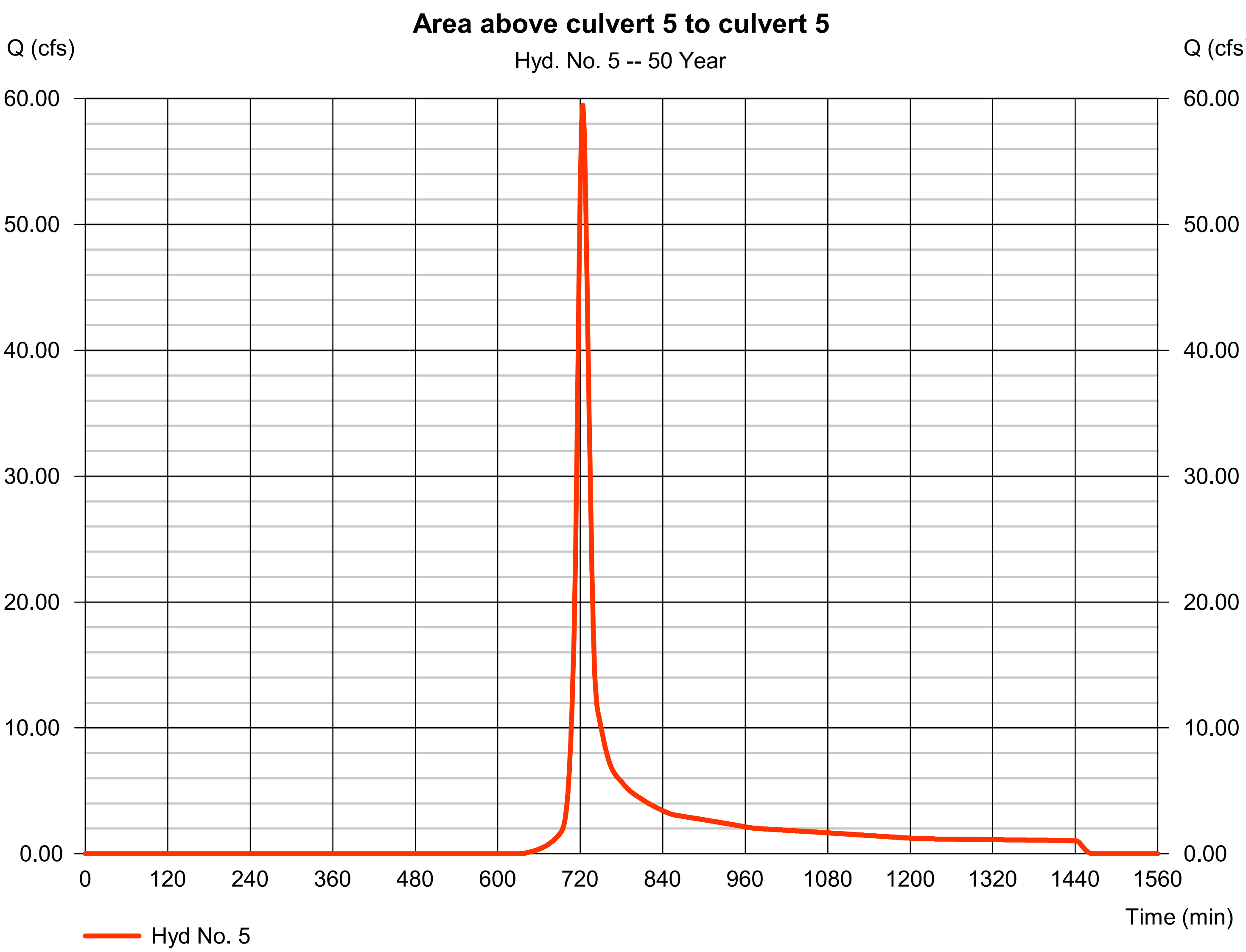
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 59.46 cfs
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 174,409 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

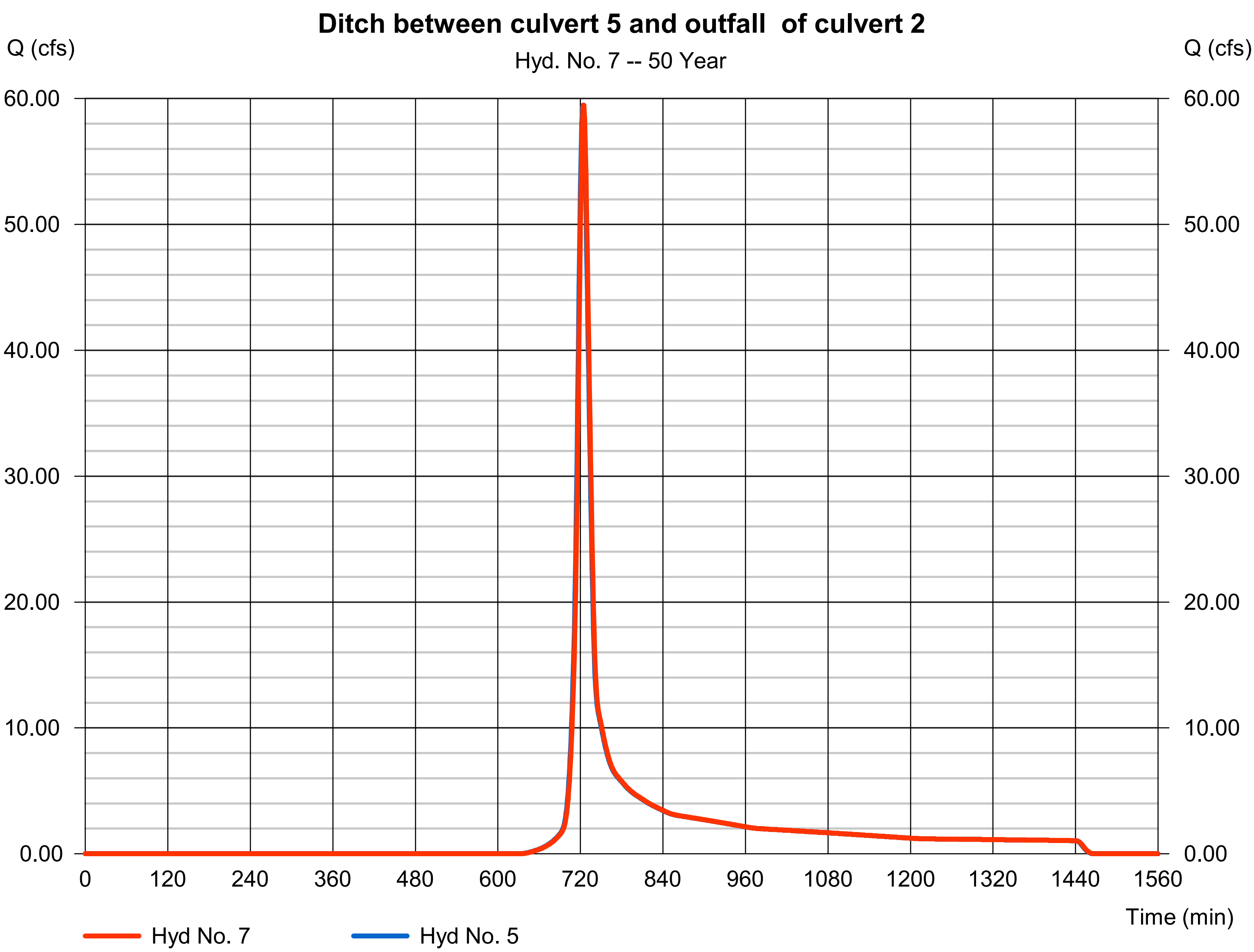
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 59.47 cfs
Storm frequency	= 50 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 174,409 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 6.15 ft/s	Routing coeff.	= 1.1395

Modified Att-Kin routing method used.



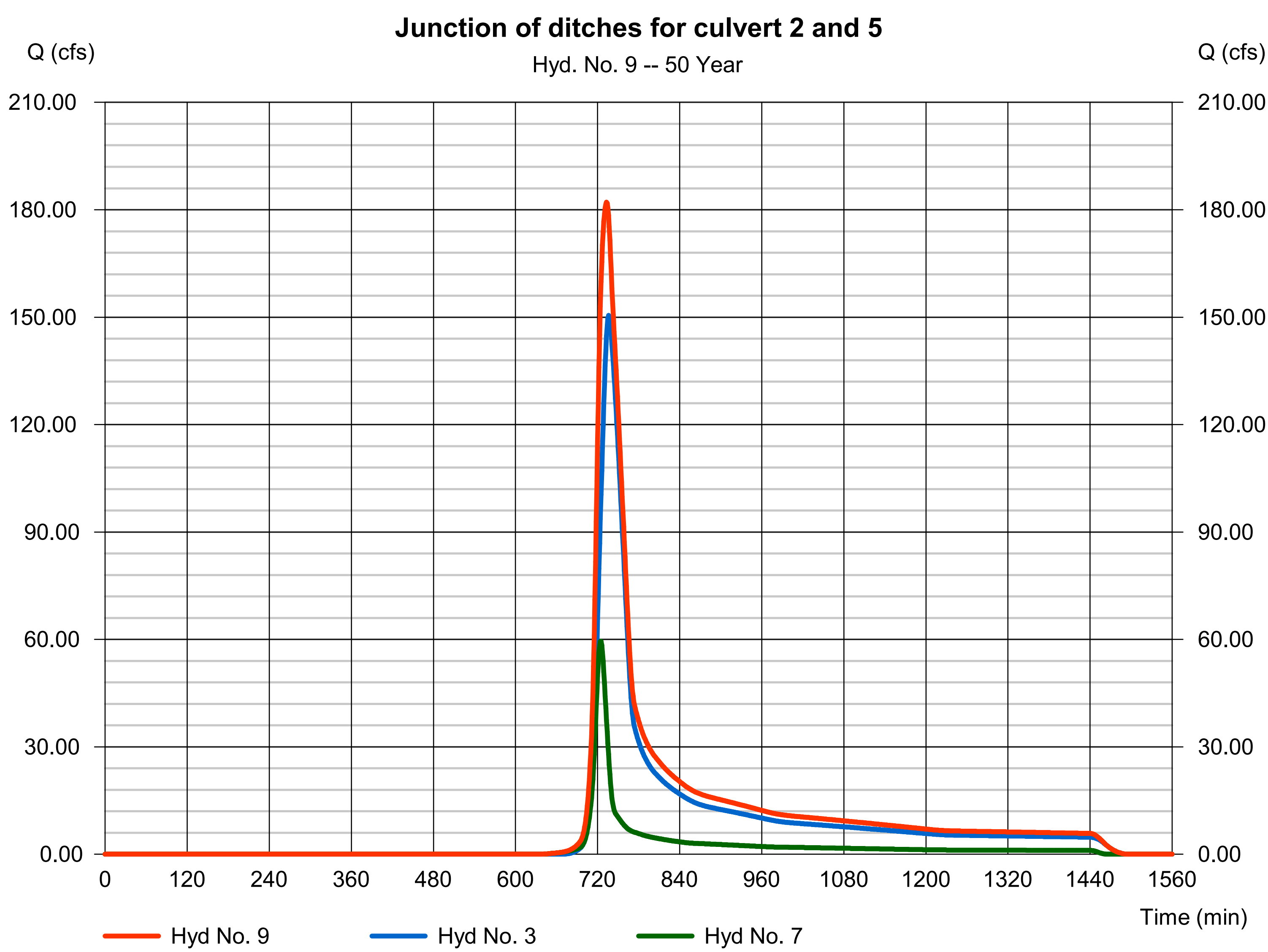
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 182.11 cfs
Storm frequency	= 50 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 902,763 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

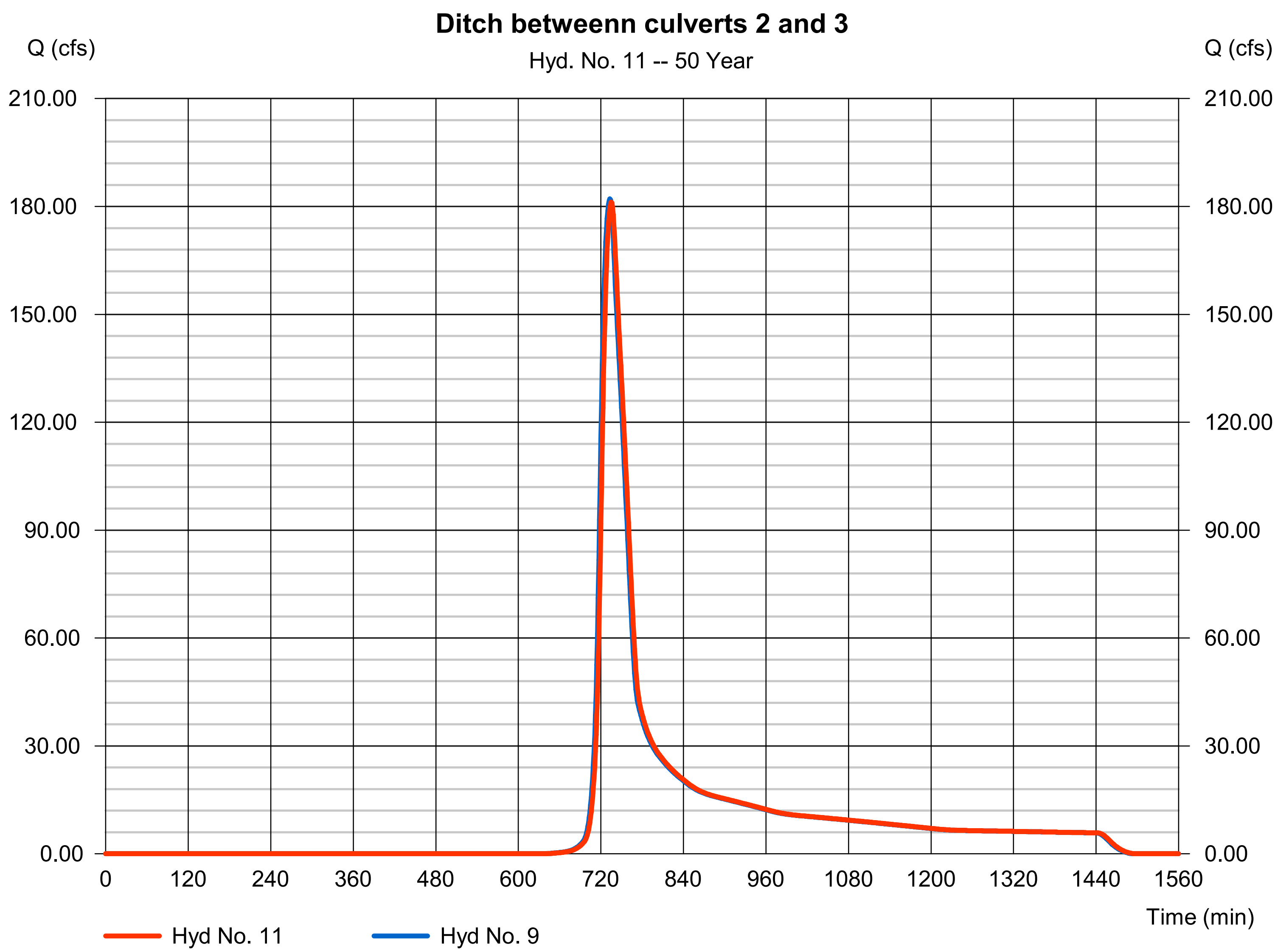
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 181.23 cfs
Storm frequency	= 50 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 902,761 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culvert 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 6.14 ft/s	Routing coeff.	= 0.4651

Modified Att-Kin routing method used.



Hydrograph Report

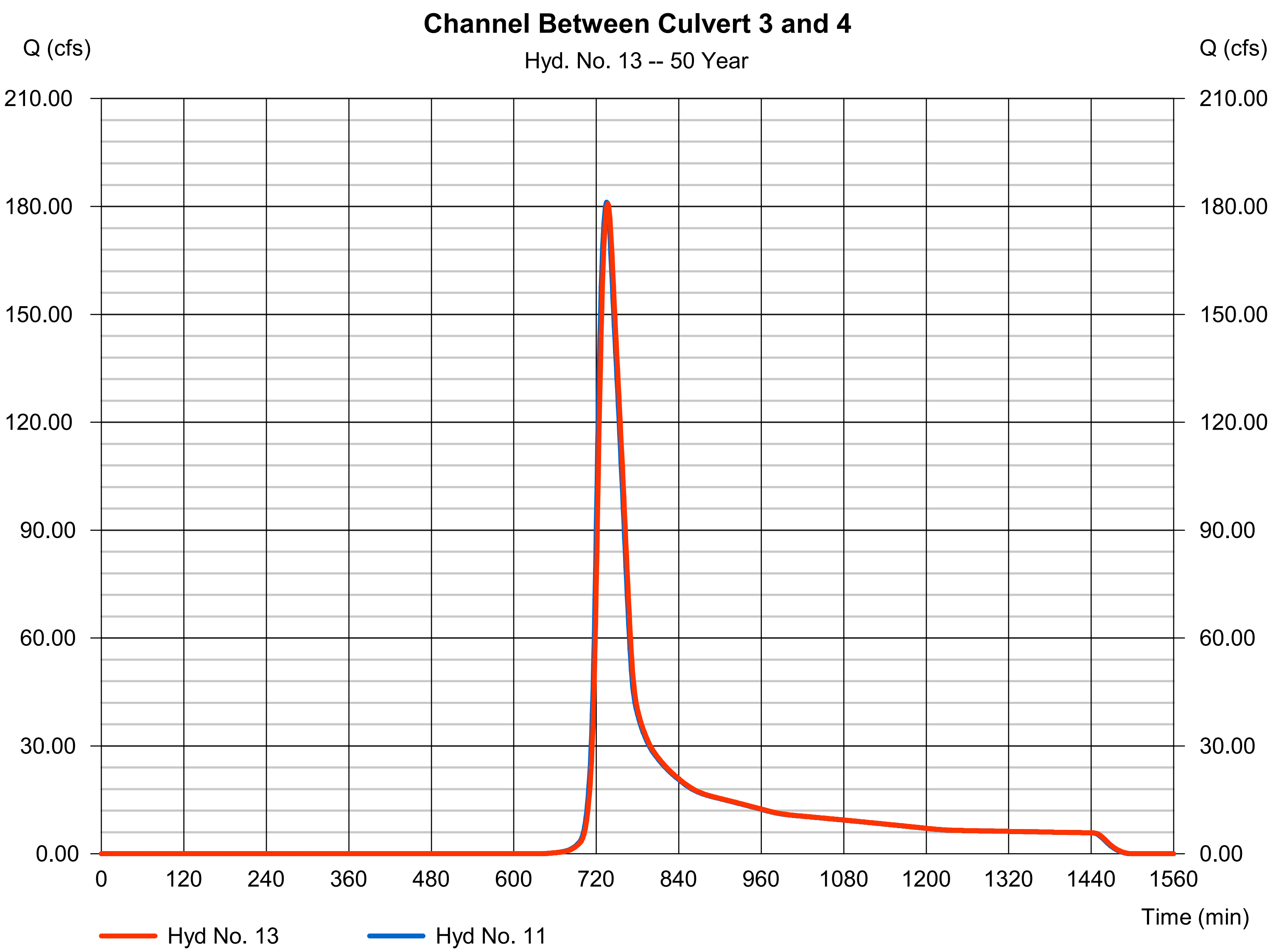
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 180.75 cfs
Storm frequency	= 50 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 902,761 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 4.55 ft/s	Routing coeff.	= 0.5720

Modified Att-Kin routing method used.



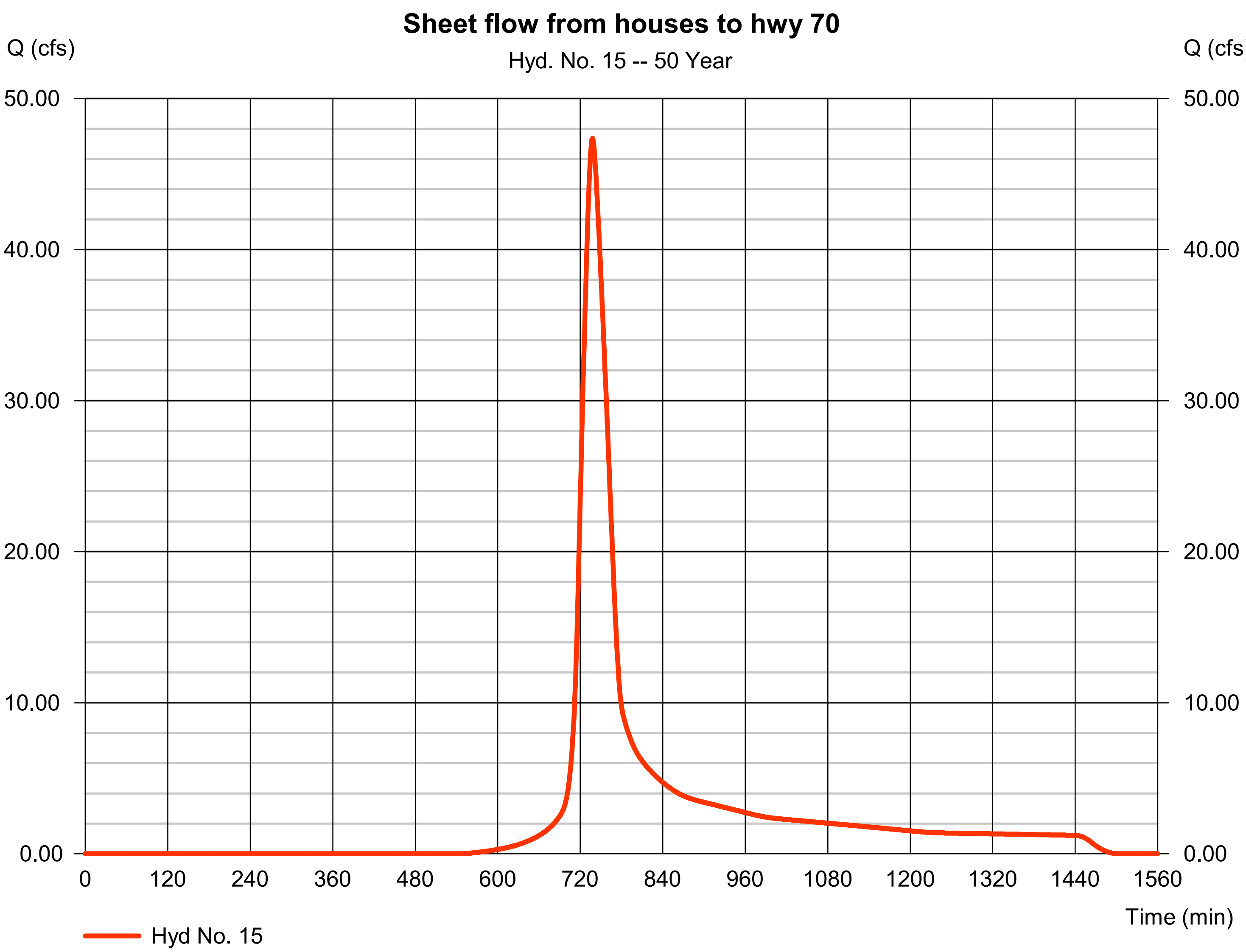
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 15

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 47.37 cfs
Storm frequency	= 50 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 232,111 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.60 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



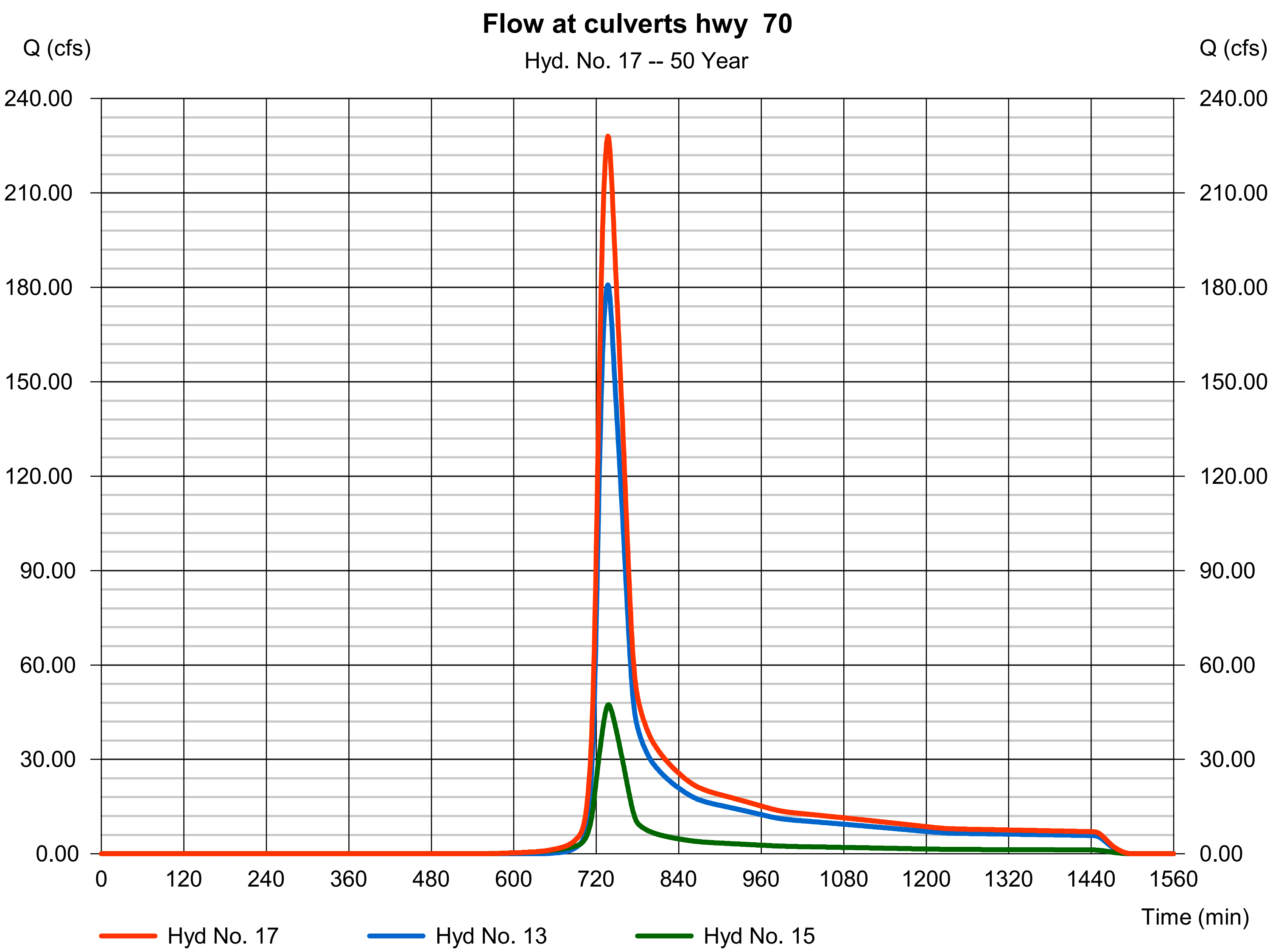
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 17

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 228.03 cfs
Storm frequency	= 50 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 1,134,870 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 20.330 ac



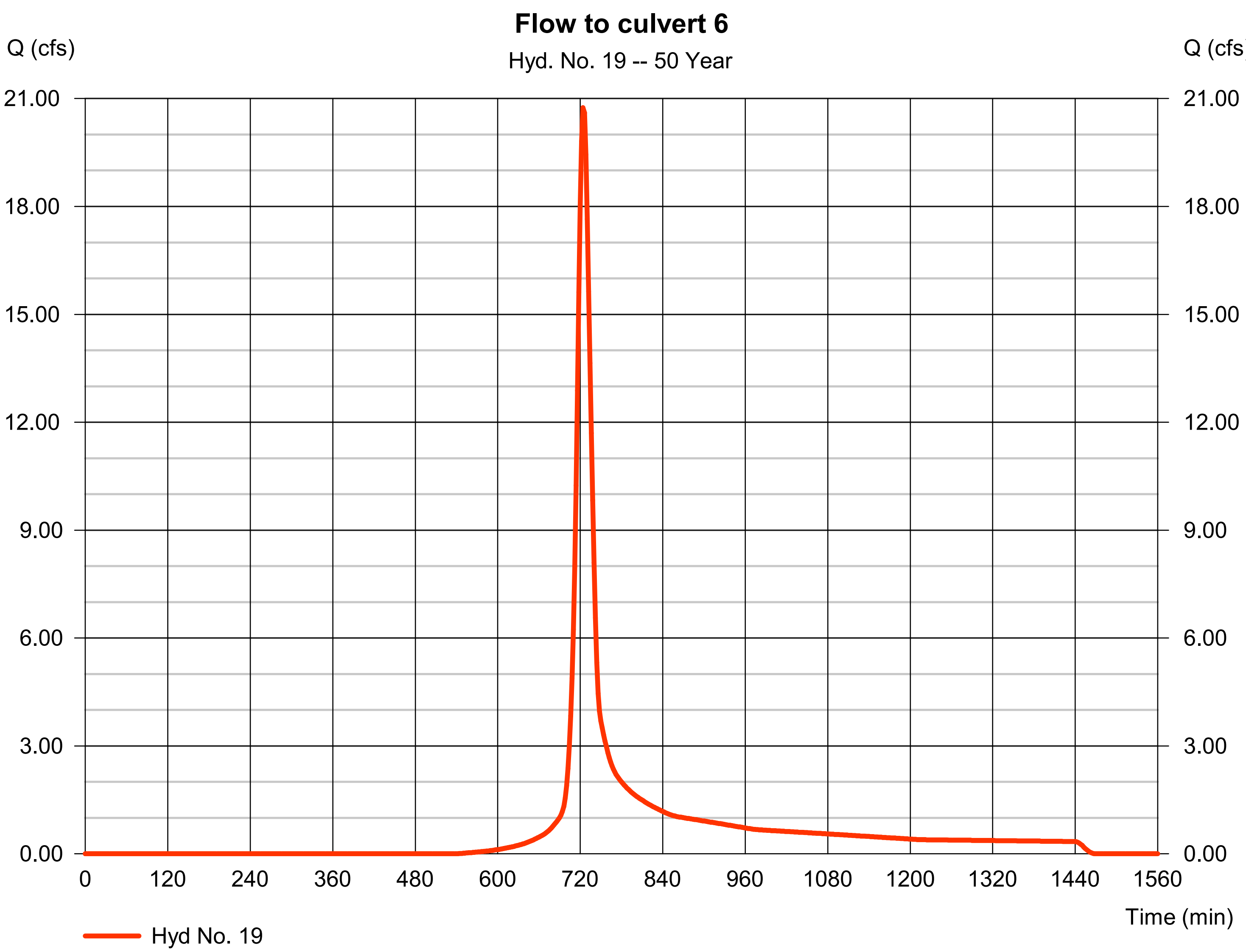
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 19

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 20.75 cfs
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 65,306 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	192.30	1	735	905,950	------	------	------	Area Above Hannah Ford leading to
3	Reach	192.53	1	736	905,950	1	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	73.57	1	724	213,534	------	------	------	Area above culvert 5 to culvert 5
7	Reach	73.68	1	724	213,534	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	231.88	1	733	1,119,485	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	230.94	1	735	1,119,484	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	230.39	1	736	1,119,483	11	------	------	Channel Between Culvert 3 and 4
15	SCS Runoff	56.85	1	738	276,957	------	------	------	Sheet flow from houses to hwy 70
17	Combine	287.05	1	737	1,396,440	13, 15,	------	------	Flow at culverts hwy 70
19	SCS Runoff	24.86	2	724	77,924	------	------	------	Flow to culvert 6

Hydrograph Report

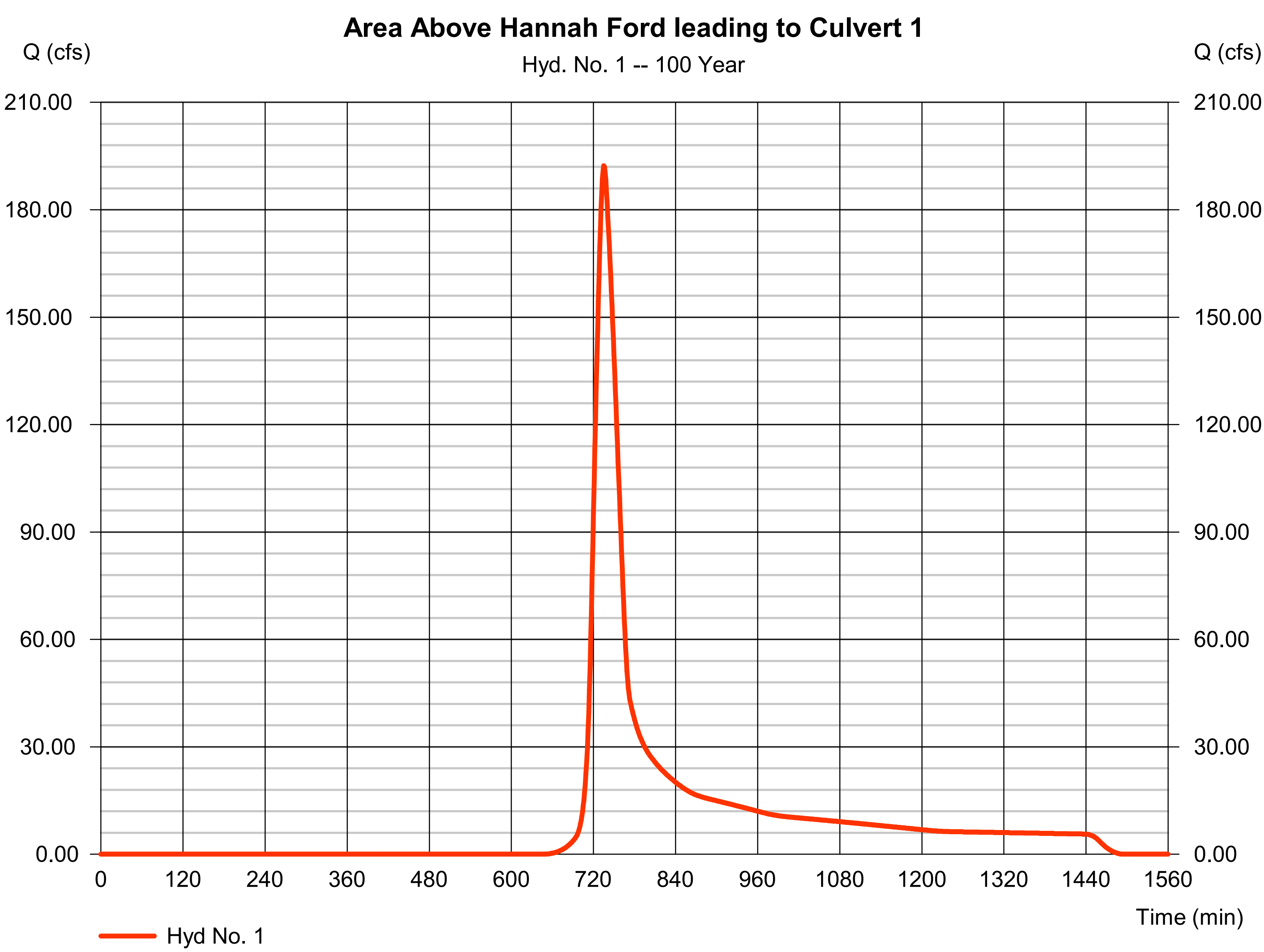
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 192.30 cfs
Storm frequency	= 100 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 905,950 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

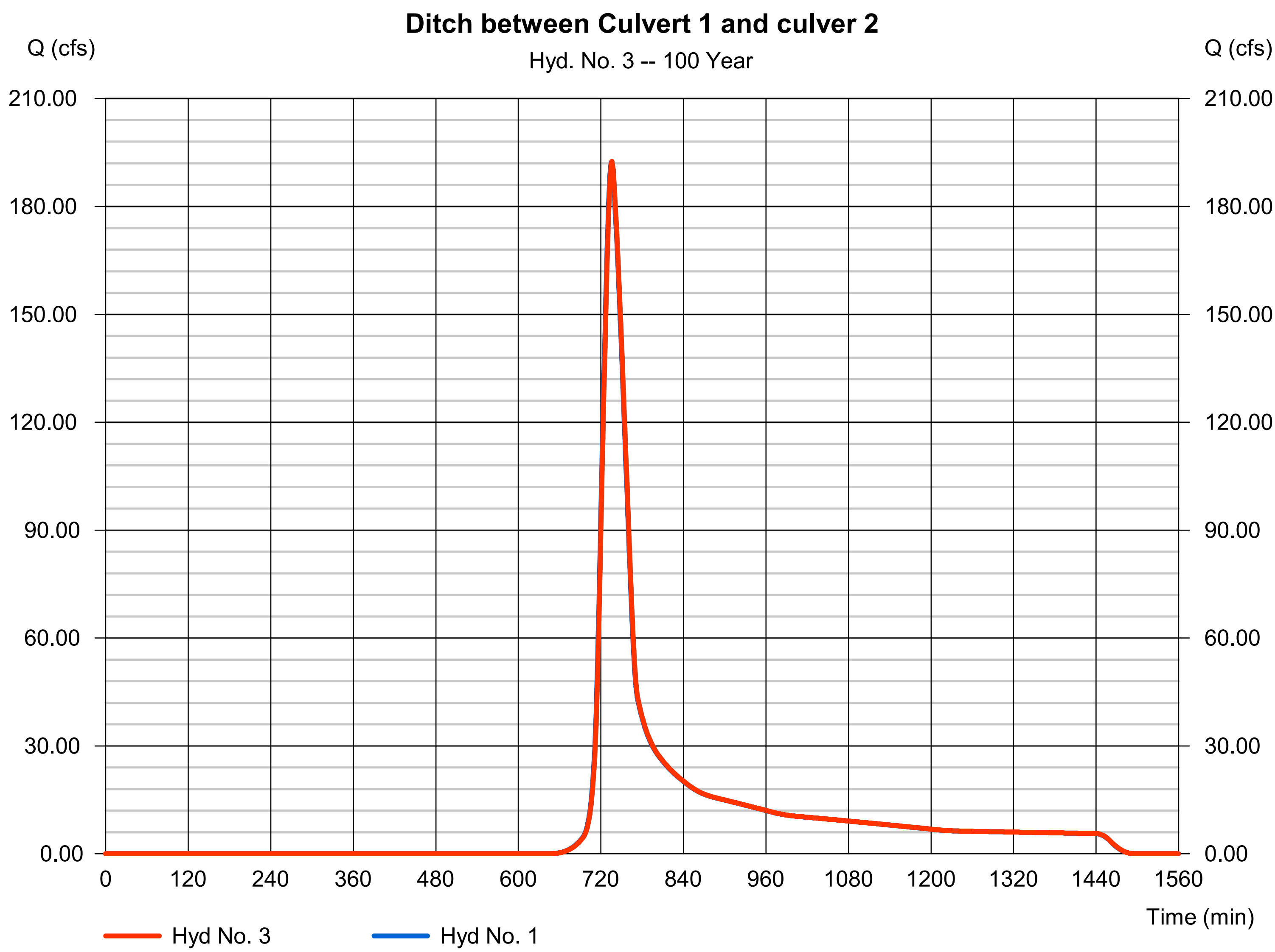
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Thursday, 03 / 2 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 192.53 cfs
Storm frequency	= 100 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 905,950 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 7.82 ft/s	Routing coeff.	= 1.4357

Modified Att-Kin routing method used.



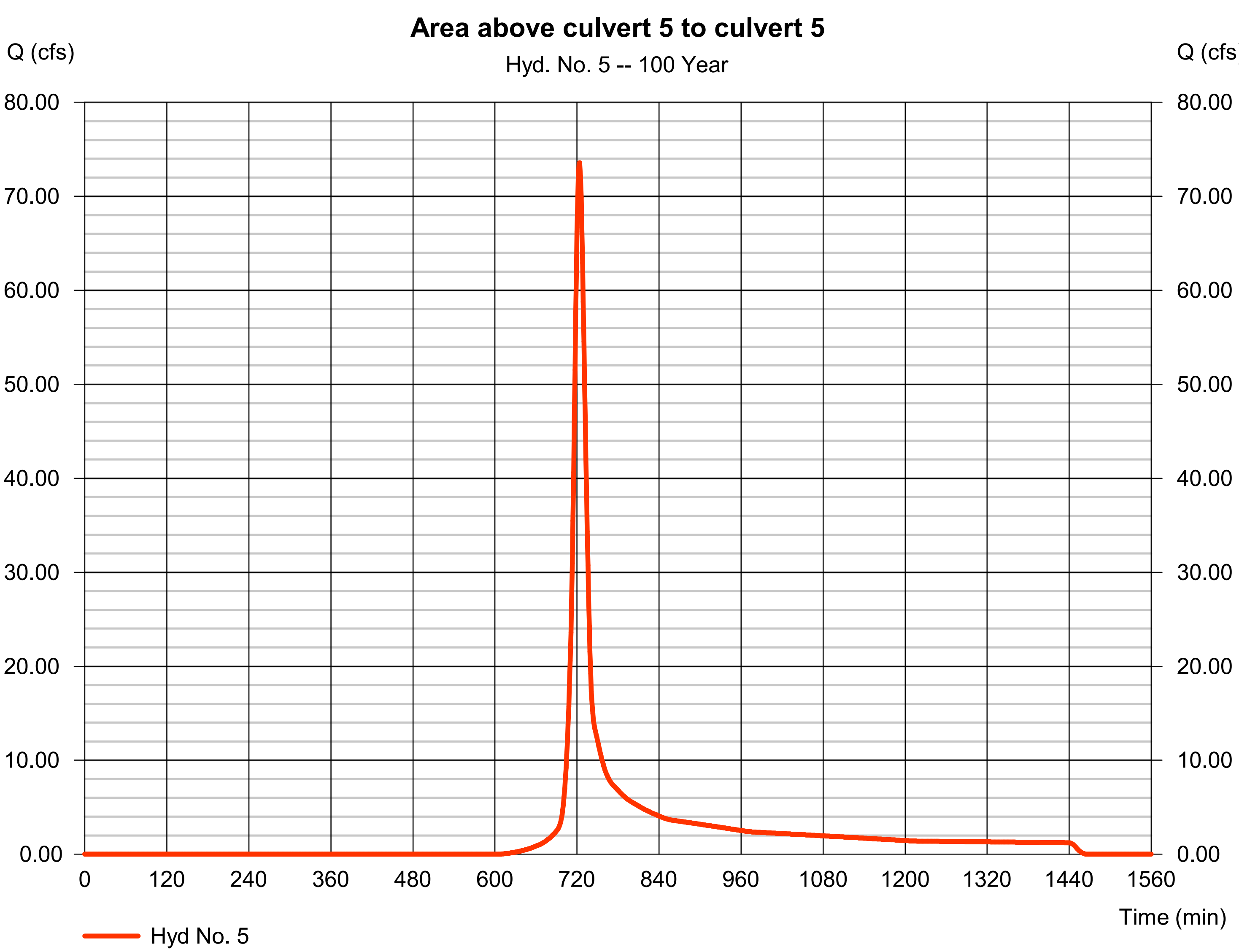
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 73.57 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 213,534 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

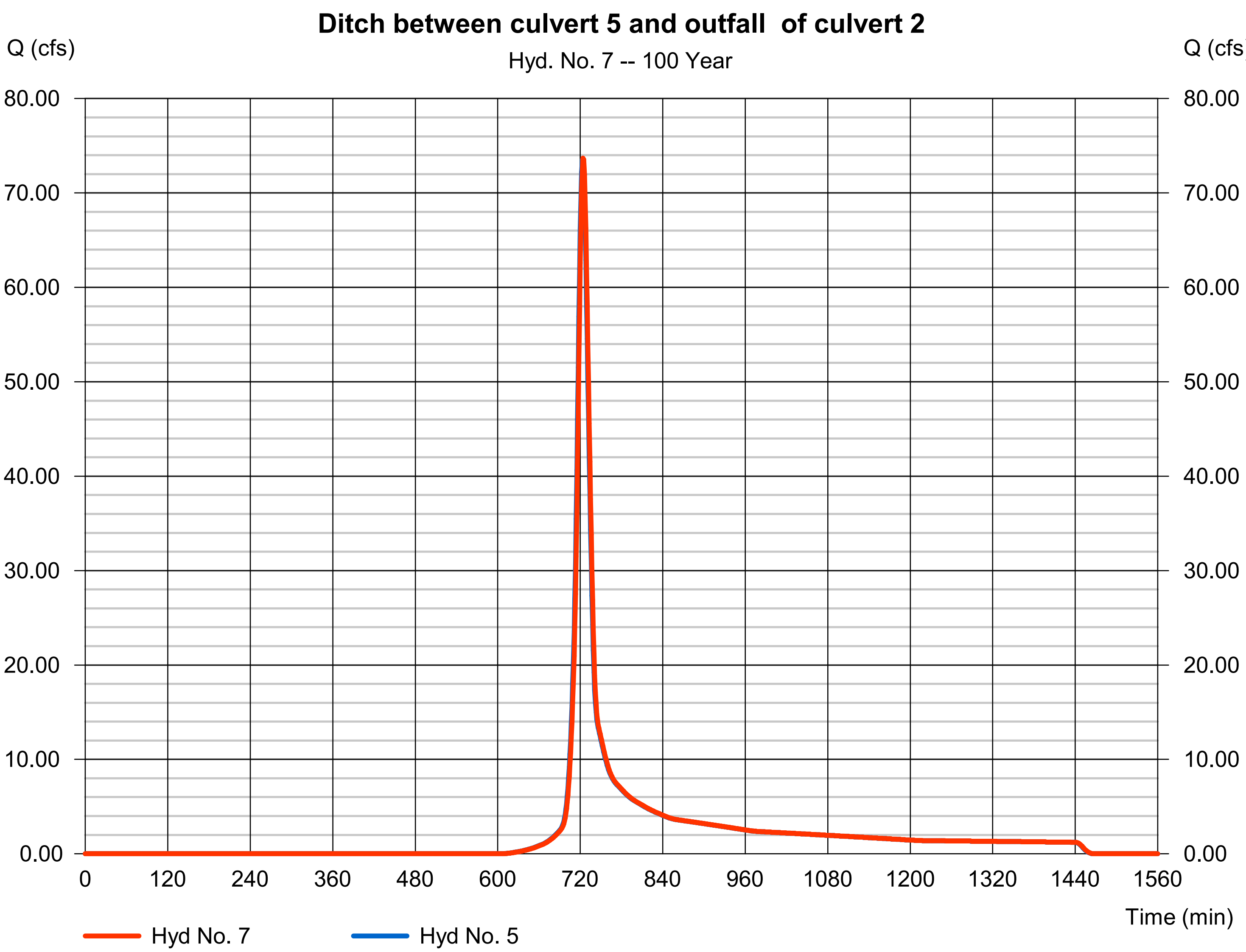
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 73.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 213,534 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 6.41 ft/s	Routing coeff.	= 1.1603

Modified Att-Kin routing method used.



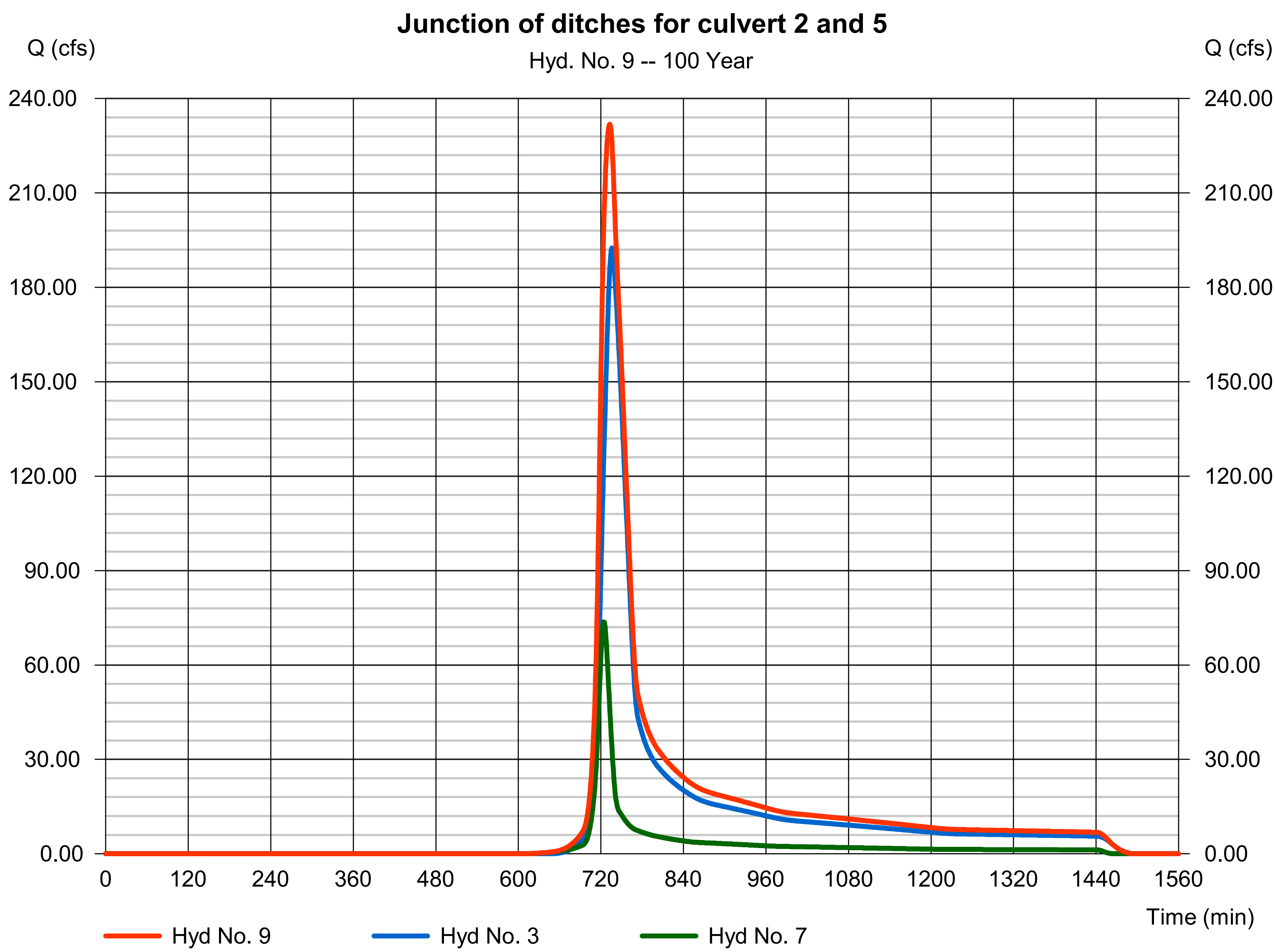
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 231.88 cfs
Storm frequency	= 100 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 1,119,485 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

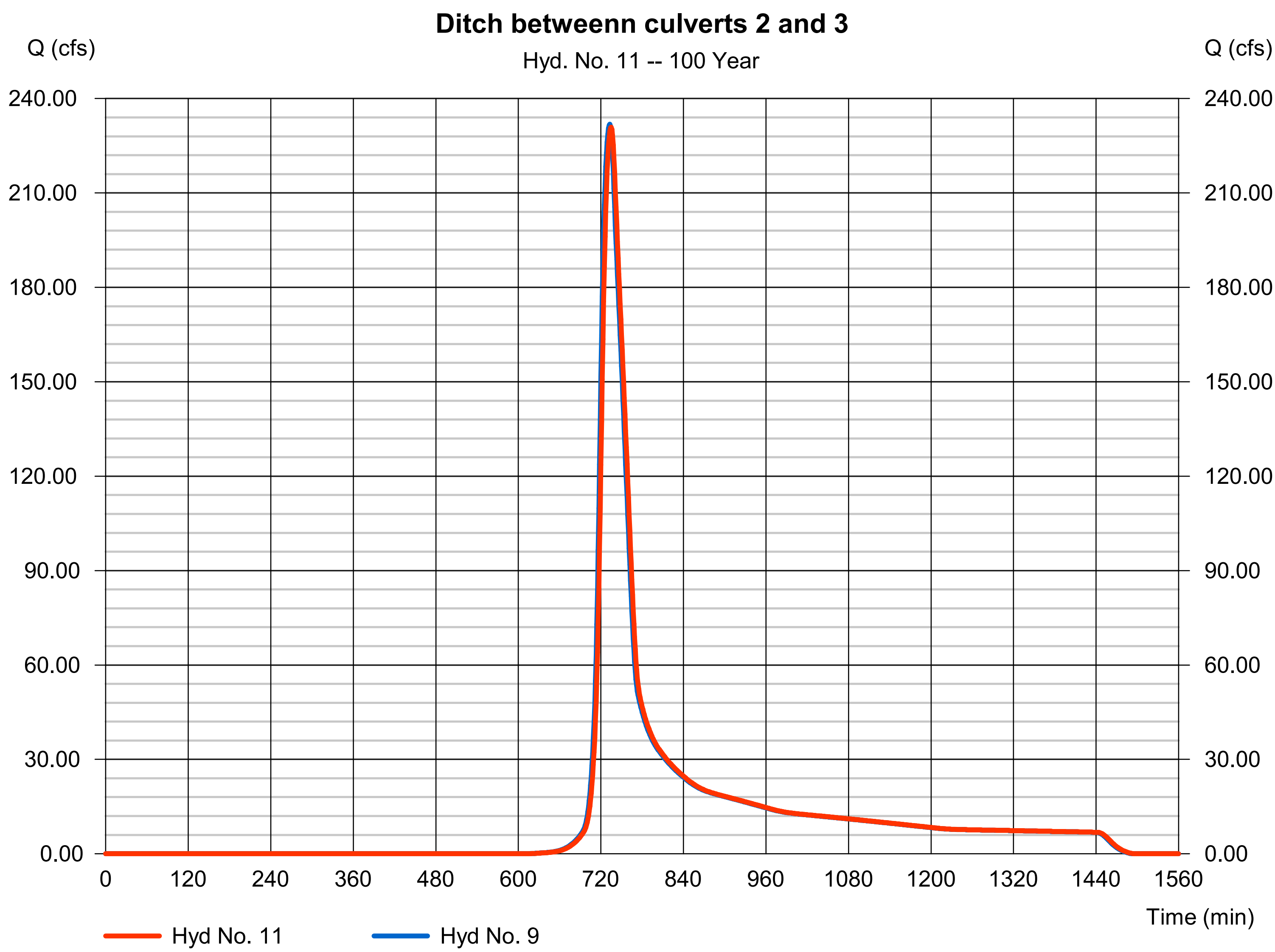
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 230.94 cfs
Storm frequency	= 100 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 1,119,484 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 6.53 ft/s	Routing coeff.	= 0.4874

Modified Att-Kin routing method used.



Hydrograph Report

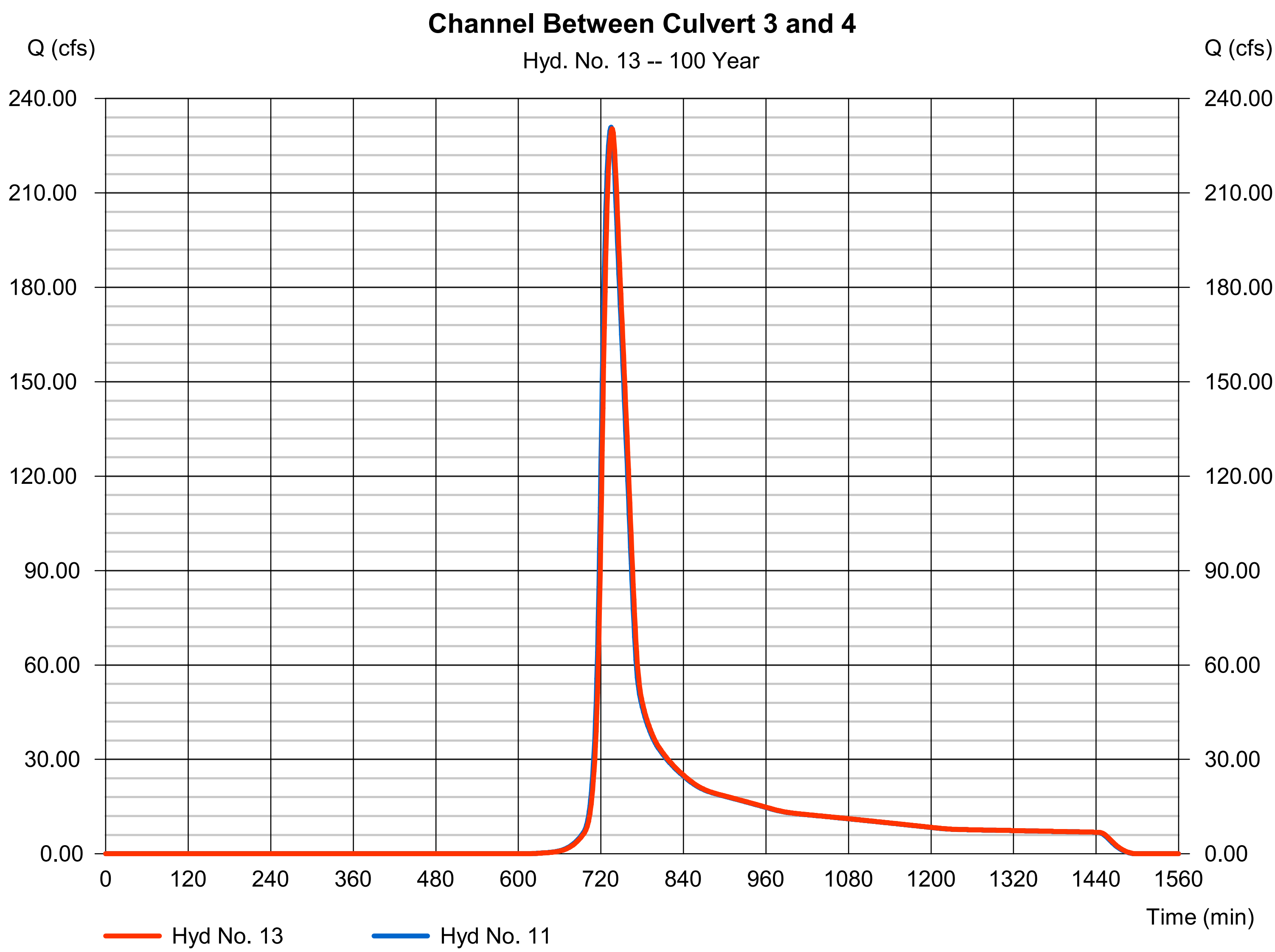
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 230.39 cfs
Storm frequency	= 100 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 1,119,483 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 4.83 ft/s	Routing coeff.	= 0.5964

Modified Att-Kin routing method used.



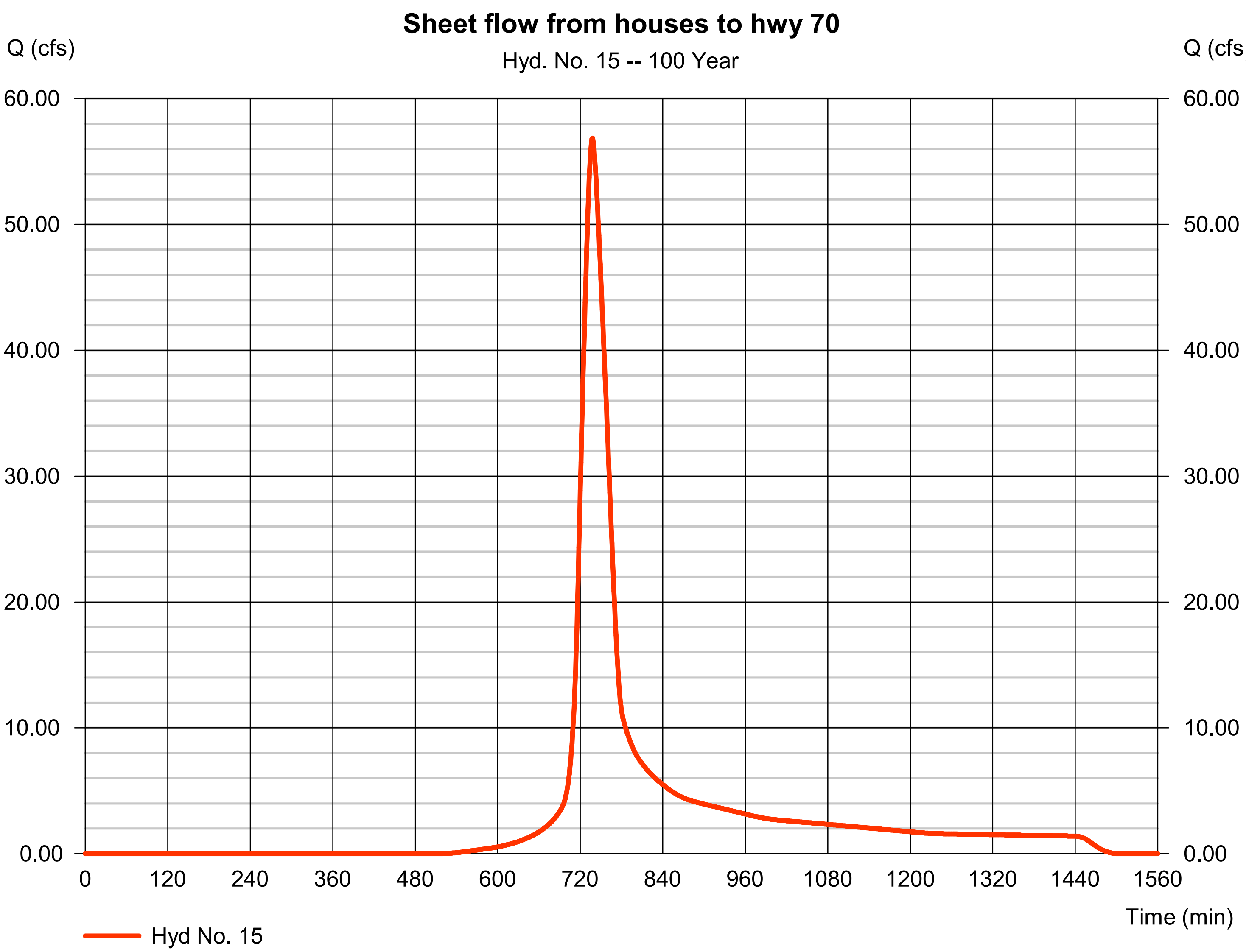
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 | Thursday, 03 / 2 / 2017

Hyd. No. 15

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 56.85 cfs
Storm frequency	= 100 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 276,957 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.60 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



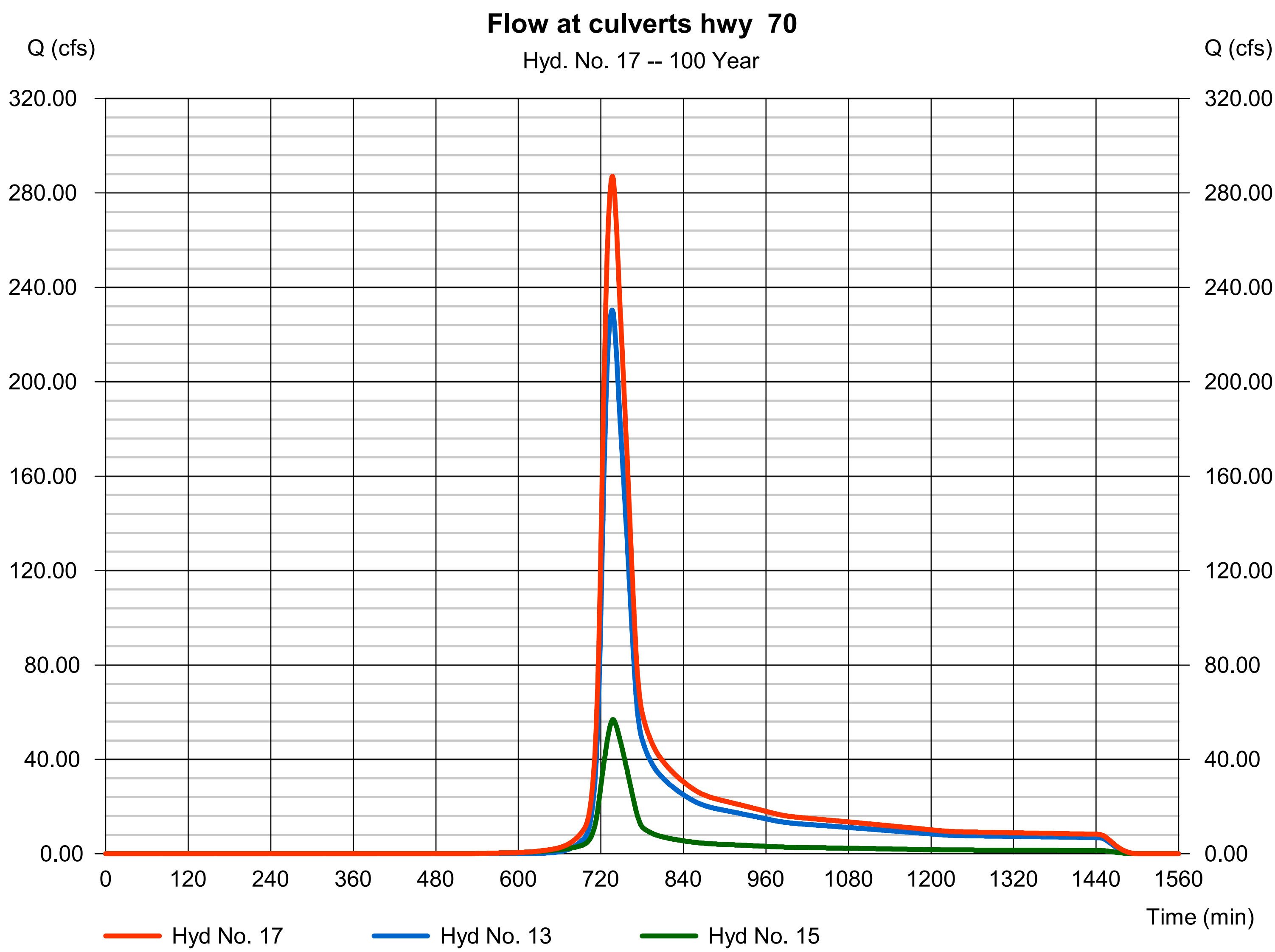
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 17

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 287.05 cfs
Storm frequency	= 100 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 1,396,440 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 20.330 ac



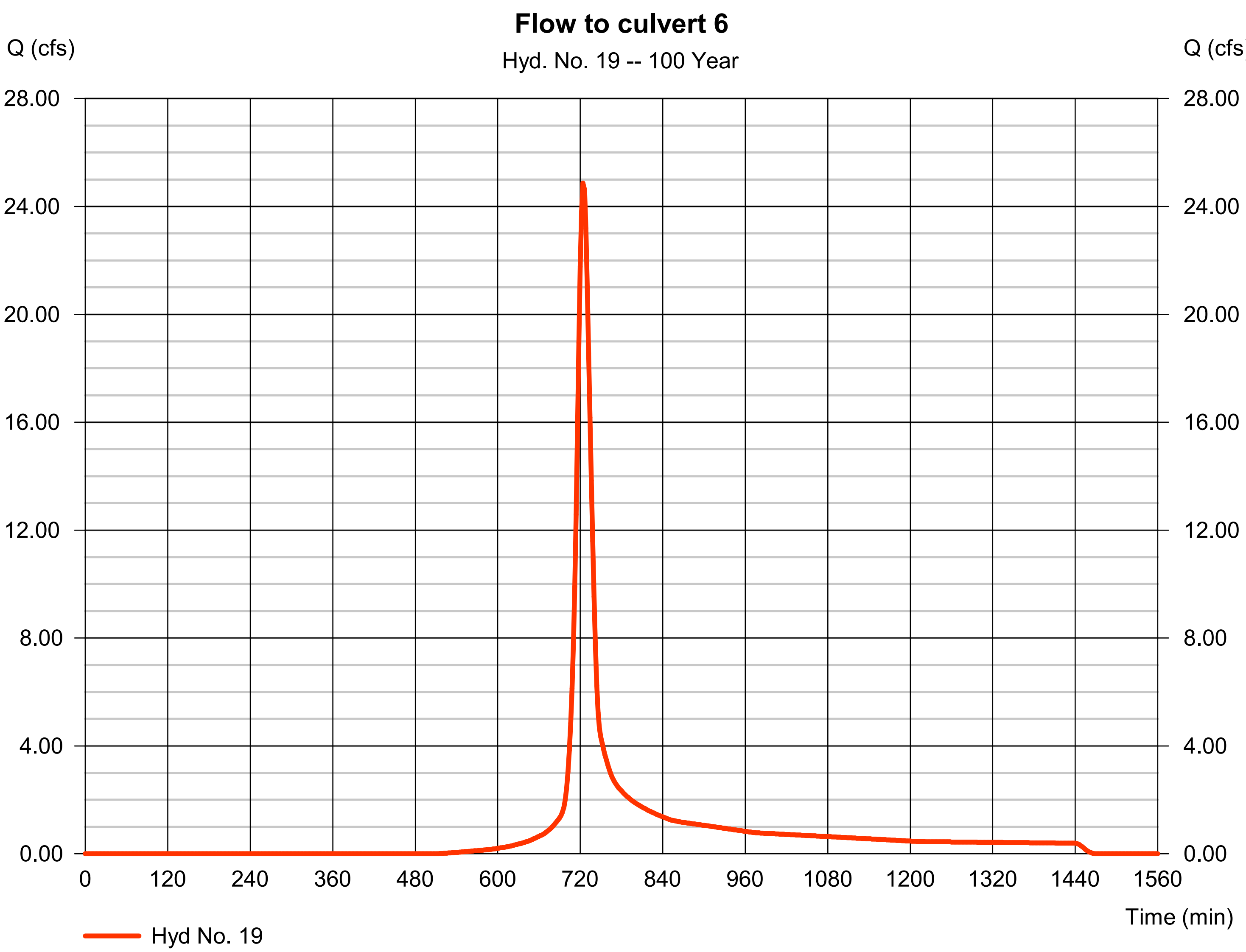
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Hyd. No. 19

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 24.86 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 77,924 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 Thursday, 03 / 2 / 2017

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	69.8703	13.1000	0.8658	--------
3	0.0000	0.0000	0.0000	--------
5	79.2597	14.6000	0.8369	--------
10	88.2351	15.5000	0.8279	--------
25	102.6072	16.5000	0.8217	--------
50	114.8193	17.2000	0.8199	--------
100	127.1596	17.8000	0.8186	--------

File name: SampleFHA.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.69	4.61	3.89	3.38	2.99	2.69	2.44	2.24	2.07	1.93	1.81	1.70
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.57	5.43	4.65	4.08	3.65	3.30	3.02	2.79	2.59	2.42	2.27	2.15
10	7.24	6.04	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.80	4.38	4.02	3.73	3.48	3.26	3.07	2.91
50	9.04	7.65	6.66	5.92	5.34	4.87	4.49	4.16	3.88	3.65	3.44	3.25
100	9.83	8.36	7.30	6.50	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

e: C:\Users\Christian\OneDrive\PEGRAM SR DESIGN\006 Design\Hydraulic Analysis\Catchment Area\Precip data.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	3.62	0.00	4.41	5.04	5.95	6.67	7.42
SCS 6-Hr	0.00	2.48	0.00	3.01	3.46	4.08	4.60	5.14
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

ENCLOSURE (F)

CULVERT ANALYSIS REPORTS

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Monday, Mar 6 2017

Culvert 1 25yr Existing Conditions

Invert Elev Dn (ft)	=	30.42
Pipe Length (ft)	=	22.01
Slope (%)	=	0.00
Invert Elev Up (ft)	=	30.42
Rise (in)	=	36.0
Shape	=	Elliptical
Span (in)	=	60.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

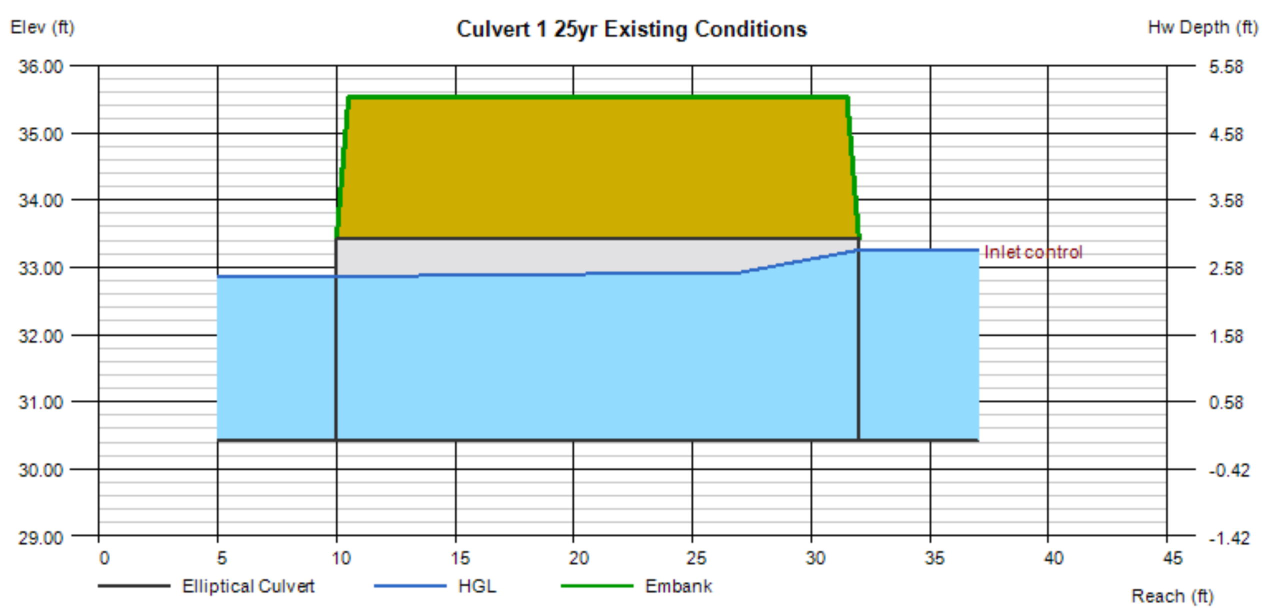
Top Elevation (ft)	=	35.53
Top Width (ft)	=	21.00
Crest Width (ft)	=	300.00

Calculations

Qmin (cfs)	=	50.00
Qmax (cfs)	=	112.65
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	50.00
Qpipe (cfs)	=	50.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.69
Veloc Up (ft/s)	=	4.69
HGL Dn (ft)	=	32.86
HGL Up (ft)	=	32.94
Hw Elev (ft)	=	33.26
Hw/D (ft)	=	0.95
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Mar 6 2017

Culvert 1 50yr

Invert Elev Dn (ft)	=	30.42
Pipe Length (ft)	=	22.01
Slope (%)	=	0.00
Invert Elev Up (ft)	=	30.42
Rise (in)	=	36.0
Shape	=	Elliptical
Span (in)	=	60.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

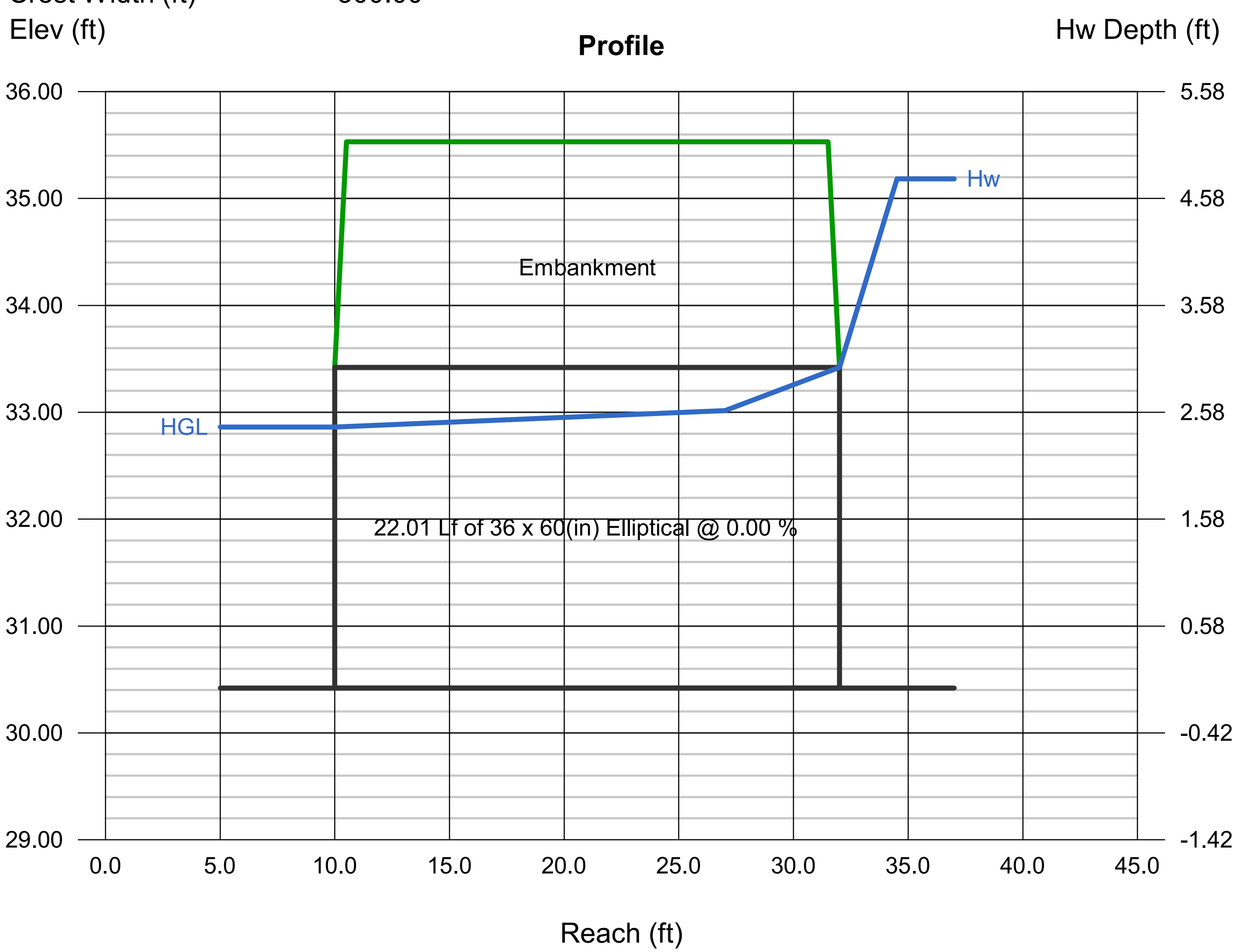
Top Elevation (ft)	=	35.53
Top Width (ft)	=	21.00
Crest Width (ft)	=	300.00

Calculations

Qmin (cfs)	=	98.00
Qmax (cfs)	=	150.27
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	98.00
Qpipe (cfs)	=	98.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.19
Veloc Up (ft/s)	=	8.90
HGL Dn (ft)	=	32.86
HGL Up (ft)	=	33.06
Hw Elev (ft)	=	35.18
Hw/D (ft)	=	1.59
Flow Regime	=	Inlet Control



Culvert Report

Culvert 2, 25yr Storm

Invert Elev Dn (ft)	=	26.98
Pipe Length (ft)	=	30.83
Slope (%)	=	4.35
Invert Elev Up (ft)	=	28.32
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

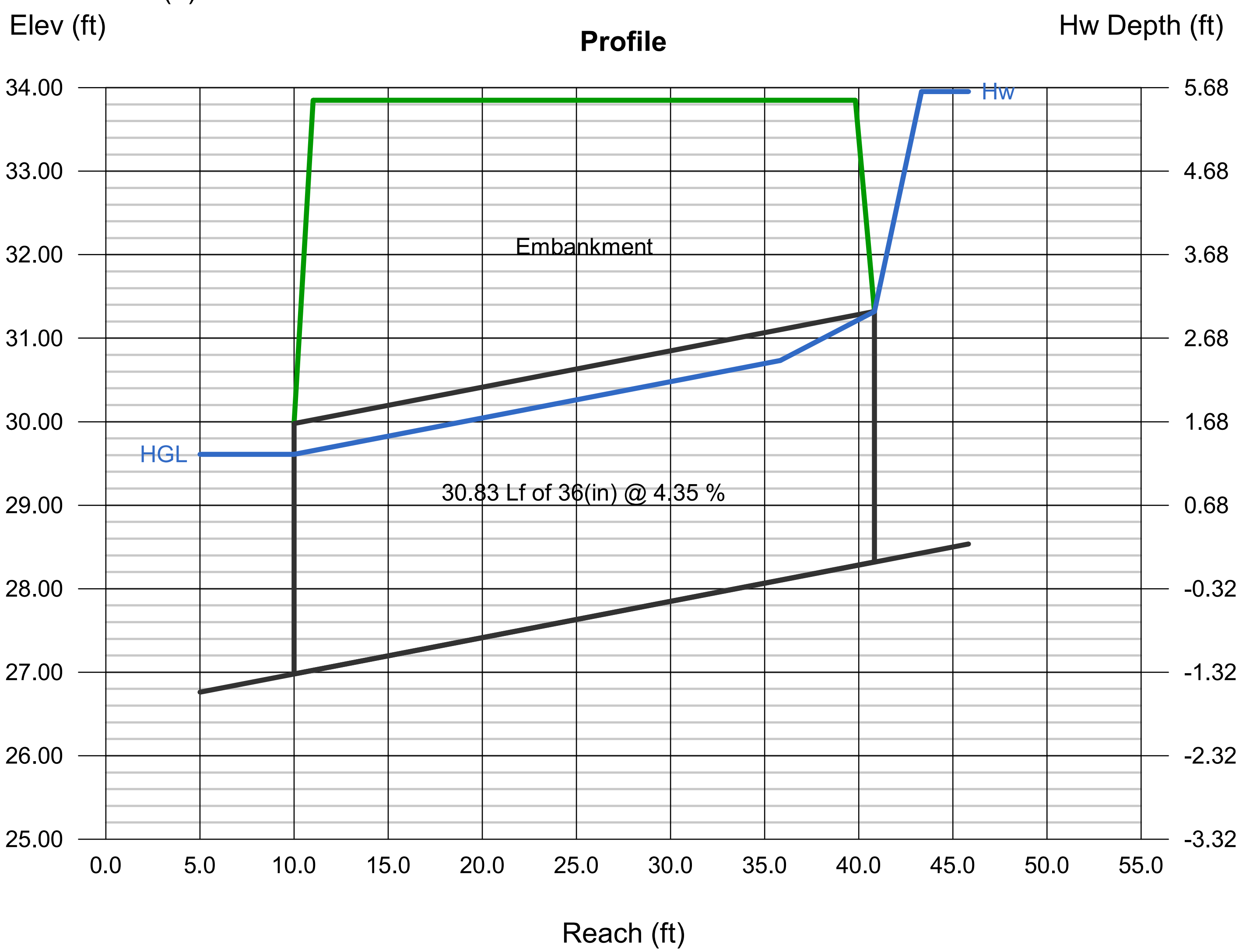
Top Elevation (ft)	=	33.85
Top Width (ft)	=	28.80
Crest Width (ft)	=	300.00

Calculations

Qmin (cfs)	=	13.00
Qmax (cfs)	=	112.65
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	103.00
Qpipe (cfs)	=	68.06
Qovertop (cfs)	=	34.94
Veloc Dn (ft/s)	=	10.36
Veloc Up (ft/s)	=	10.36
HGL Dn (ft)	=	29.61
HGL Up (ft)	=	30.95
Hw Elev (ft)	=	33.95
Hw/D (ft)	=	1.88
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Mar 6 2017

Culvert 2 50 yr Existing Conditions

Invert Elev Dn (ft)	=	26.98
Pipe Length (ft)	=	30.83
Slope (%)	=	4.35
Invert Elev Up (ft)	=	28.32
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

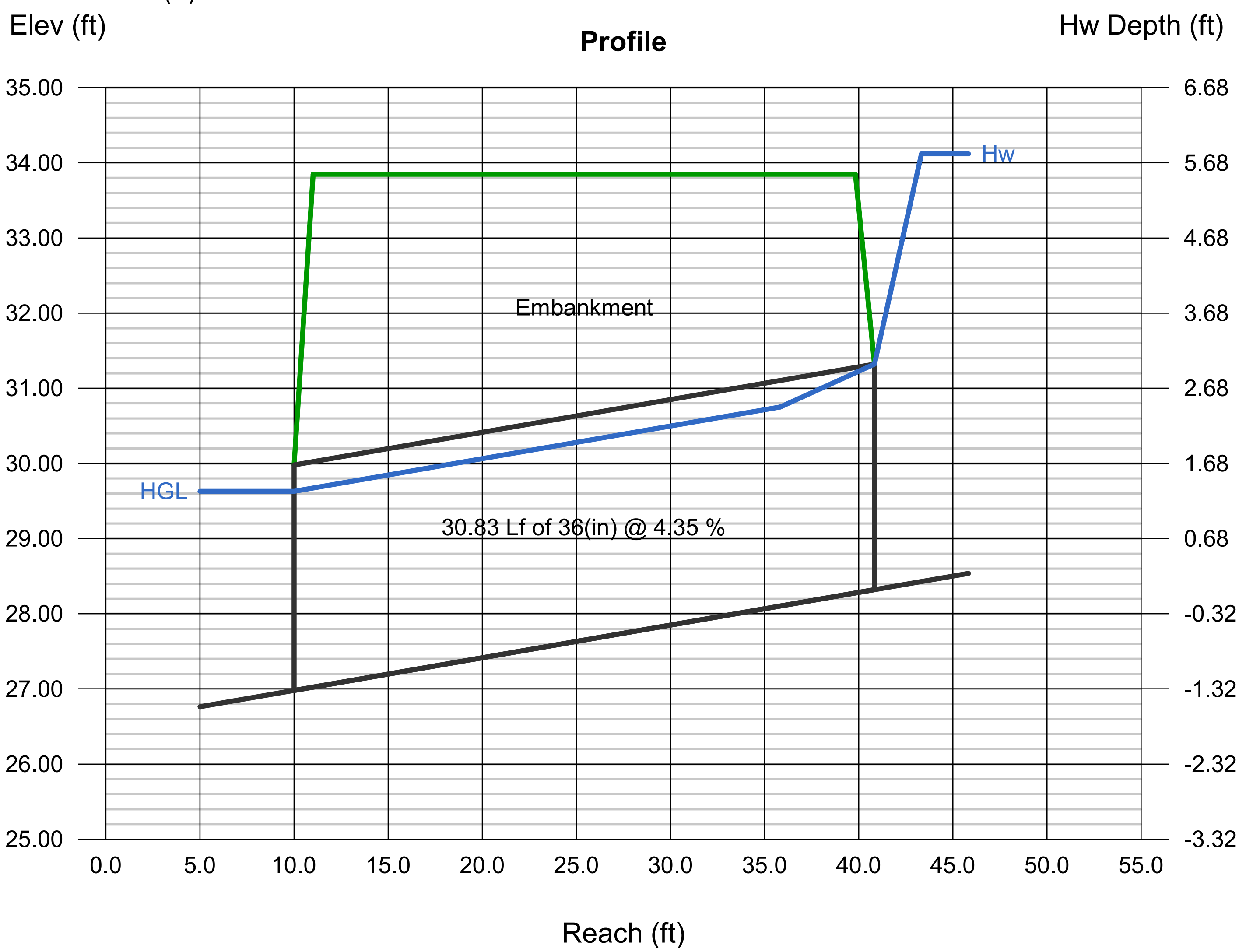
Top Elevation (ft)	=	33.85
Top Width (ft)	=	28.80
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	13.00
Qmax (cfs)	=	112.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	112.00
Qpipe (cfs)	=	69.57
Qovertop (cfs)	=	42.43
Veloc Dn (ft/s)	=	10.53
Veloc Up (ft/s)	=	10.53
HGL Dn (ft)	=	29.63
HGL Up (ft)	=	30.97
Hw Elev (ft)	=	34.12
Hw/D (ft)	=	1.93
Flow Regime	=	Inlet Control



Culvert Report

Culvert 3, 25 yr Storm

Invert Elev Dn (ft)	=	7.57
Pipe Length (ft)	=	33.24
Slope (%)	=	2.17
Invert Elev Up (ft)	=	8.29
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

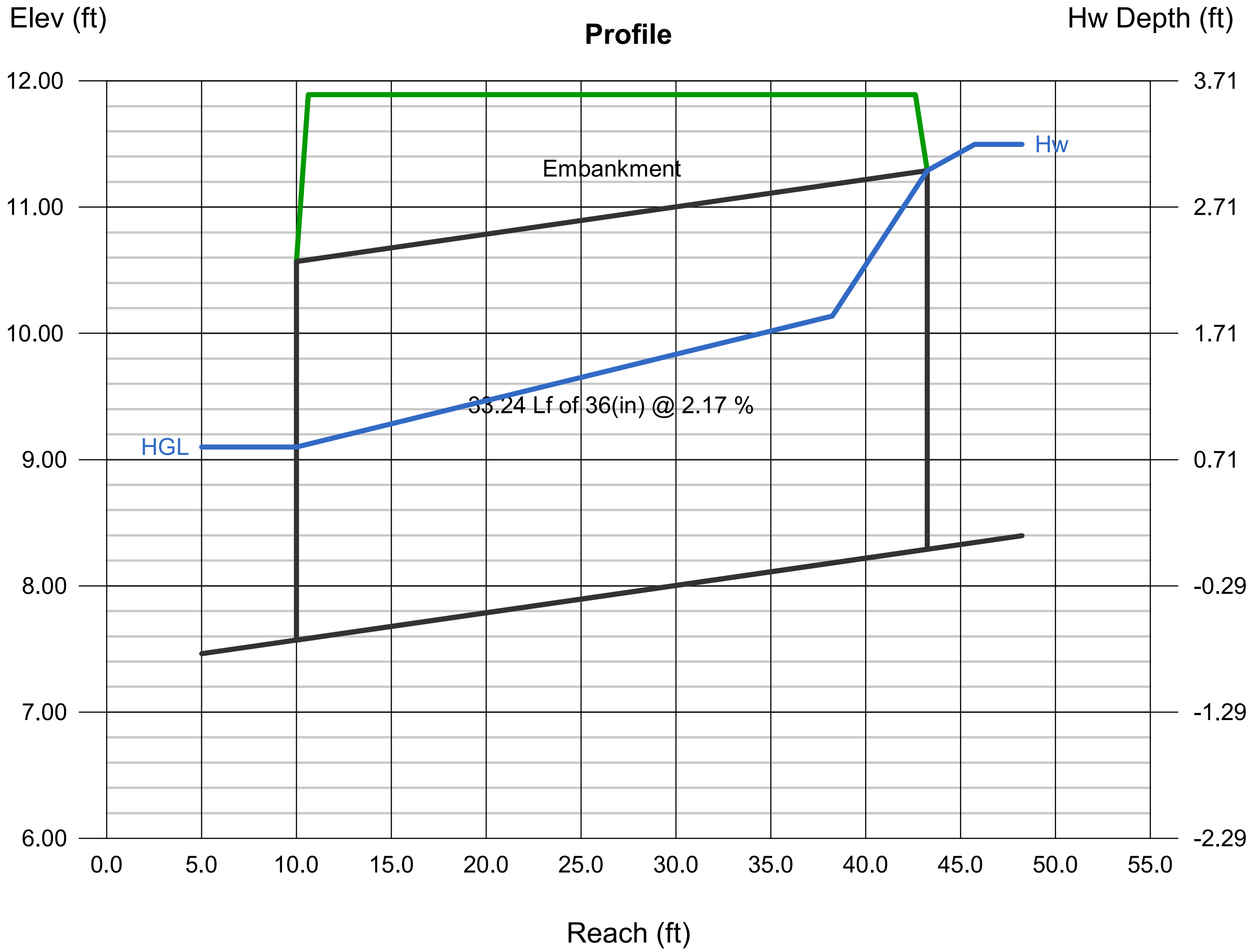
Top Elevation (ft)	=	11.89
Top Width (ft)	=	32.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	37.00
Qmax (cfs)	=	136.38
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	117.00
Qpipe (cfs)	=	117.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.77
Veloc Up (ft/s)	=	7.66
HGL Dn (ft)	=	9.10
HGL Up (ft)	=	10.32
Hw Elev (ft)	=	11.50
Hw/D (ft)	=	1.07
Flow Regime	=	Inlet Control



Culvert Report

Culvert 3 50yr Existing Conditions

Invert Elev Dn (ft)	= 7.57
Pipe Length (ft)	= 33.24
Slope (%)	= 2.17
Invert Elev Up (ft)	= 8.29
Rise (in)	= 36.0
Shape	= Circular
Span (in)	= 36.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

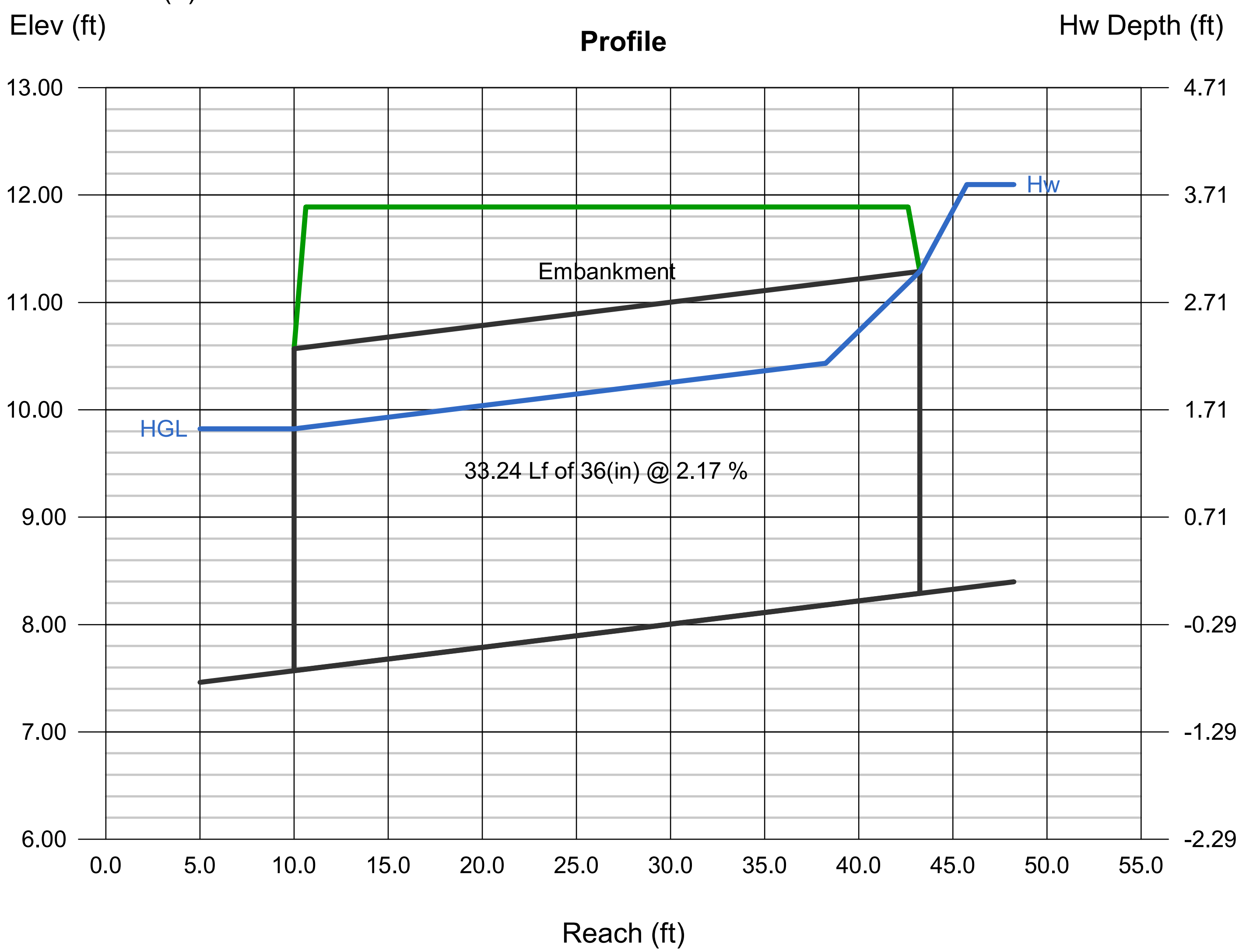
Top Elevation (ft)	= 11.89
Top Width (ft)	= 32.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 82.00
Qmax (cfs)	= 181.23
Tailwater Elev (ft)	= Normal

Highlighted

Qtotal (cfs)	= 172.00
Qpipe (cfs)	= 143.82
Qovertop (cfs)	= 28.18
Veloc Dn (ft/s)	= 8.42
Veloc Up (ft/s)	= 8.42
HGL Dn (ft)	= 9.82
HGL Up (ft)	= 10.54
Hw Elev (ft)	= 12.10
Hw/D (ft)	= 1.27
Flow Regime	= Inlet Control



Culvert Report

Culvert 2, 25yr Storm

Invert Elev Dn (ft)	=	26.98
Pipe Length (ft)	=	30.83
Slope (%)	=	4.35
Invert Elev Up (ft)	=	28.32
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

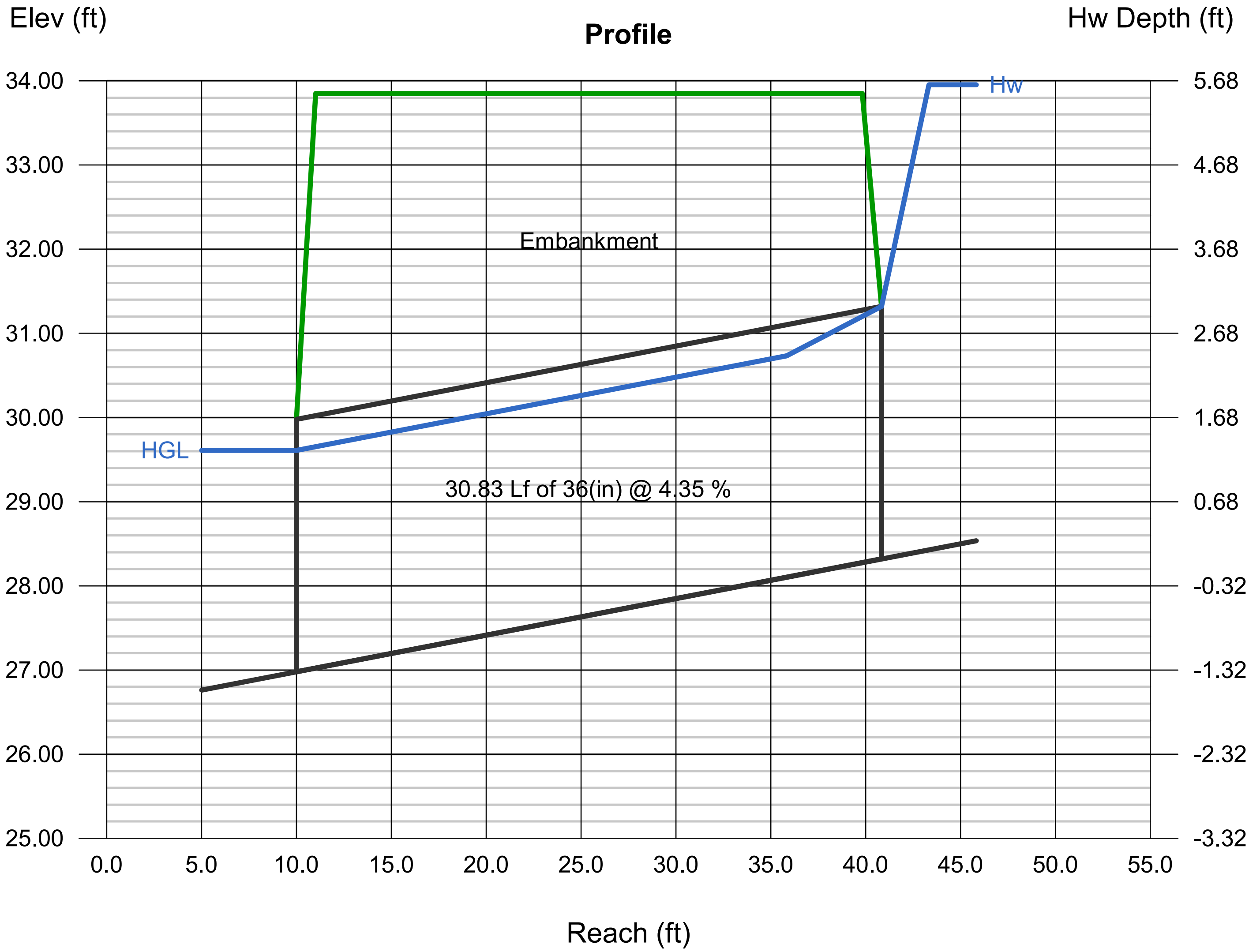
Top Elevation (ft)	=	33.85
Top Width (ft)	=	28.80
Crest Width (ft)	=	300.00

Calculations

Qmin (cfs)	=	13.00
Qmax (cfs)	=	112.65
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	103.00
Qpipe (cfs)	=	68.06
Qovertop (cfs)	=	34.94
Veloc Dn (ft/s)	=	10.36
Veloc Up (ft/s)	=	10.36
HGL Dn (ft)	=	29.61
HGL Up (ft)	=	30.95
Hw Elev (ft)	=	33.95
Hw/D (ft)	=	1.88
Flow Regime	=	Inlet Control



Culvert Report

Culvert 4 25yr Existing Conditions

Invert Elev Dn (ft)	=	1.31
Pipe Length (ft)	=	50.42
Slope (%)	=	1.27
Invert Elev Up (ft)	=	1.95
Rise (in)	=	18.0
Shape	=	Elliptical
Span (in)	=	30.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

Top Elevation (ft)	=	4.93
Top Width (ft)	=	49.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	75.00
Qmax (cfs)	=	175.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	175.00
Qpipe (cfs)	=	69.54
Qovertop (cfs)	=	105.46
Veloc Dn (ft/s)	=	8.20
Veloc Up (ft/s)	=	9.05
HGL Dn (ft)	=	2.66
HGL Up (ft)	=	3.15
Hw Elev (ft)	=	5.41
Hw/D (ft)	=	2.31
Flow Regime	=	Inlet Control

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. | Wednesday, Apr 5 2017

Culvert 4 50yr Existing Conditions

Invert Elev Dn (ft)	=	1.31
Pipe Length (ft)	=	50.42
Slope (%)	=	1.27
Invert Elev Up (ft)	=	1.95
Rise (in)	=	18.0
Shape	=	Elliptical
Span (in)	=	30.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

Top Elevation (ft)	=	4.93
Top Width (ft)	=	49.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	228.03
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	220.00
Qpipe (cfs)	=	71.29
Qovertop (cfs)	=	148.71
Veloc Dn (ft/s)	=	8.40
Veloc Up (ft/s)	=	9.27
HGL Dn (ft)	=	2.66
HGL Up (ft)	=	3.15
Hw Elev (ft)	=	5.54
Hw/D (ft)	=	2.39
Flow Regime	=	Inlet Control

Culvert Report

Culvert 4 100yr Existing Conditions

Invert Elev Dn (ft)	= 1.31
Pipe Length (ft)	= 50.42
Slope (%)	= 1.27
Invert Elev Up (ft)	= 1.95
Rise (in)	= 18.0
Shape	= Elliptical
Span (in)	= 30.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Horizontal Ellipse Concrete
Culvert Entrance	= Square edge w/headwall (H)
Coeff. K,M,c,Y,k	= 0.01, 2, 0.0398, 0.67, 0.5

Embankment

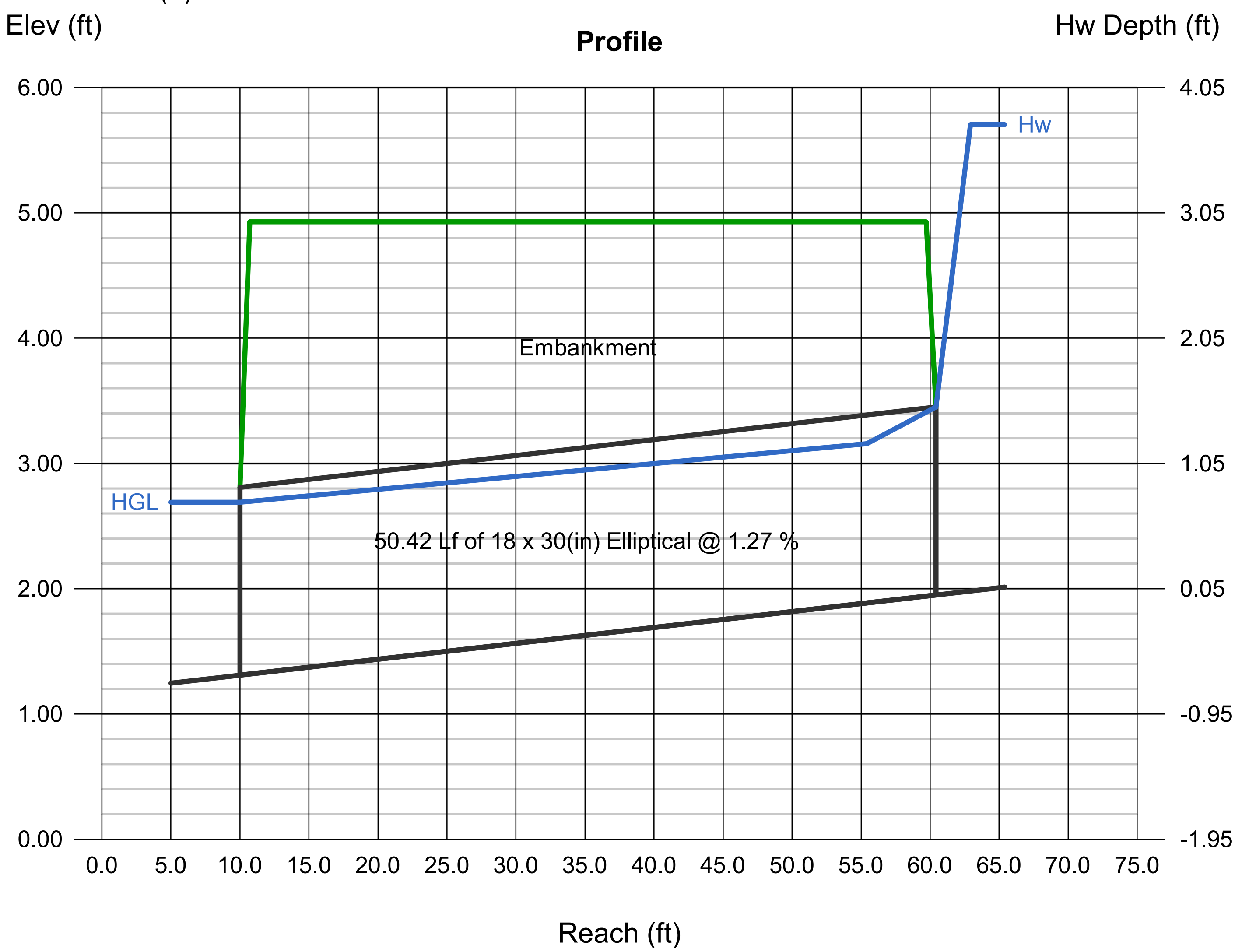
Top Elevation (ft)	= 4.93
Top Width (ft)	= 49.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 200.00
Qmax (cfs)	= 287.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 287.00
Qpipe (cfs)	= 73.57
Qovertop (cfs)	= 213.43
Veloc Dn (ft/s)	= 8.45
Veloc Up (ft/s)	= 9.20
HGL Dn (ft)	= 2.69
HGL Up (ft)	= 3.21
Hw Elev (ft)	= 5.70
Hw/D (ft)	= 2.50
Flow Regime	= Inlet Control



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COLLEGE OF ENGINEERING

Enclosure (E):

Design Development Package

RAYMOND B. JONES COLLEGE OF ENGINEERING

Pegram Highway 70 Flood Remediation

Final Design Narrative

(FOR THEORETICAL USE ONLY – NOT FOR CONSTRUCTION)

April 2017

Highway 70 Shopping Area
500 Block Hwy 70
Pegram, TN 37143

Enclosures:

A. Design Development Drawings
B. Hydrology Report
C. Culvert / Channel Analysis Reports
D. Construction Cost Estimate
E. Maintenance Agreement

Contributors:
Nathan Curtis
David Lowery
Cody Glenn
Abigail Queen
Christian Reid

Introduction:

The Lipscomb University senior design team was asked by the city of Pegram to address a flooding issue that takes place at three culverts running under Highway 70 near the 500 block. It was suspected that these culverts were not meeting TDOT standards, however there was no qualitative data to back up the claim. The following is our analysis of the existing conditions of the culverts at the 500 block of Hwy 70 as well as the culverts along the flow path to Hwy 70.

Research & Analysis:

We set out in the fall of 2017 to gather survey data around the place of flooding, in hopes that it would help inform our hydraulic analysis. Our survey covered the area bounded by Highway 70, Dogwood Lane, and Hannah Ford Road. The completed survey can be seen in enclosure (A). This data, along with GIS data, was used to analyze the watershed and current culvert conditions. We found that each of the culverts along the flow path of interest (flowing south from Hannah Ford Rd along the ditch to HWY 70), are failing per TDOT standards as seen in Figure 1.

TDOT Standards:

	Interstate System and Arterial With Full Access Control	Arterial Without Full Access Control	Collector	Local Road
Inlet Design Frequency	50-yr	10-yr [1]	10-yr [1]	10-yr
Sewer Design Frequency	50-yr	10-yr [1]	10-yr [1]	10-yr
Culvert Design Frequency	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr
Roadway Freeboard [2]	50-yr	50-yr	50-yr	50-yr
Ditch Design Frequency	50-yr	10-yr [1]	10-yr [1]	10-yr

Figure 1 TDOT Current Culvert Standards

Per the TDOT standards shown above, all culverts are to be designed for a 50 year storm, and if feasible, for the 100 year storm. Each of the culverts along the flow path are failing under the 50-year storm conditions.

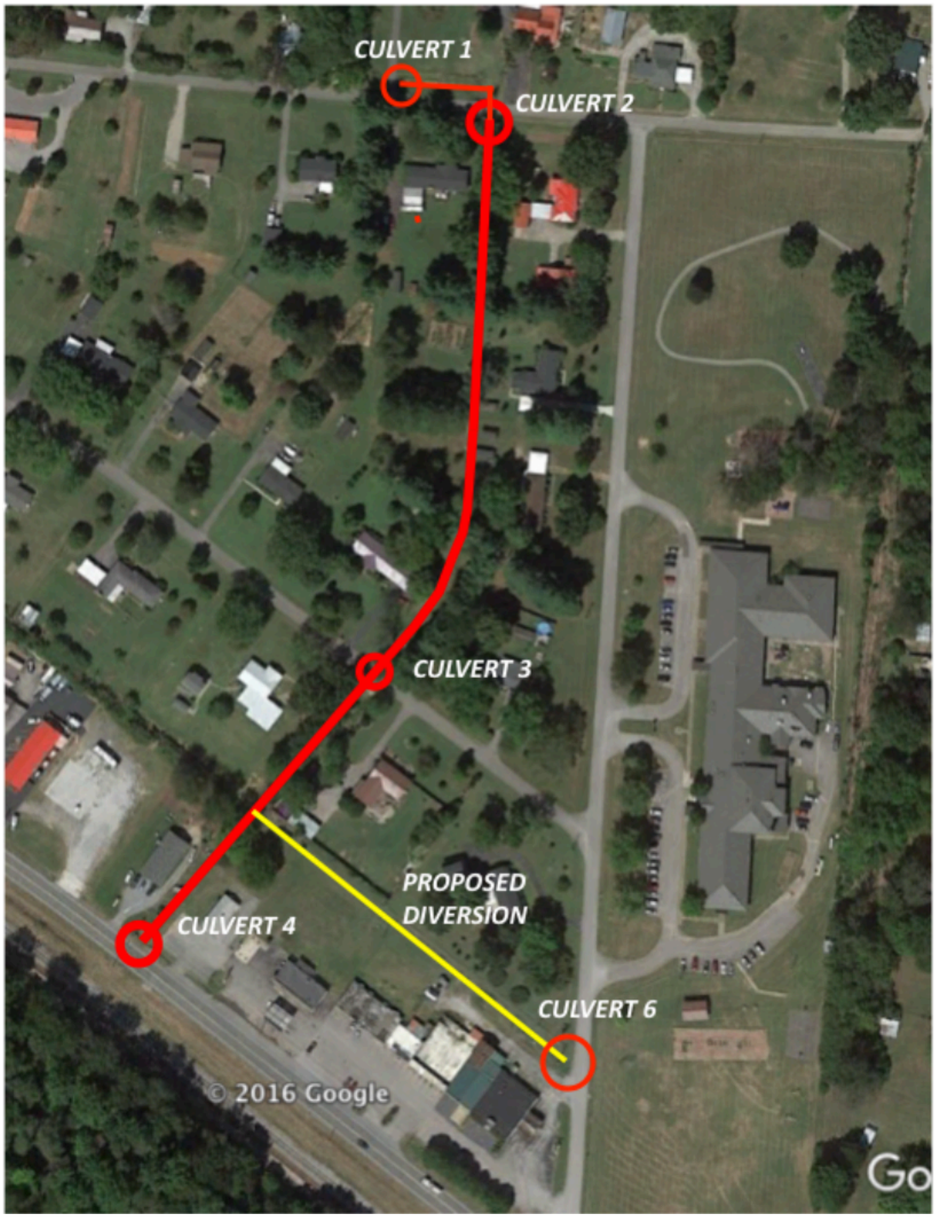

Figure 2. Naming Convention

For ease of reference, *Figure 2 (Above)* shows the naming convention used for each of the culverts along the flow path. This can be seen in more detail in *Enclosure (A).*

The results of our analysis for a both the existing conditions, as well as proposed conditions during a 50 year storm event can be seen summarized in *Table 1* (below).

CULVERT DATA ALONG FLOWPATH FOR 50 YEAR STORM – EXISTING						
CULVERT NAME	# OF CULVERTS	SIZE OF CULVERTS	CULVERT CAPACITY (CFS)	TOTAL INCOMING FLOW (CFS)	FLOW OVERTOPPING (CFS)	DEPTH OF FLOW OVERTOPPING ROAD
1	1	36X60" ELLIPTICAL	106	148	41	3 IN.
2	1	36" ROUND	68	103	34	1.8 IN.
3	3	36" ROUND	143	172	28	2.4 IN.
4	3	18X30" ELLIPTICAL	64	220	125	5 IN.

CULVERT DATA ALONG FLOWPATH FOR 50 YEAR STORM – AFTER PROPOSED CONSTRUCTION					
CULVERT NAME	# OF CULVERTS	SIZE OF CULVERTS	CULVERT CAPACITY (CFS)	TOTAL INCOMING FLOW (CFS)	FLOW OVERTOPPING (CFS)
1	1	36X60" ELLIPTICAL	106	37	0
2	1	36" ROUND	68	37	0
3	3	36" ROUND	143	65	0
4	3	18X30" ELLIPTICAL	64	47	0
6	3	24X40" ELLIPTICAL	100	95	0

Table 1 Culvert Analysis under 50-yr Storm Conditions

Proposed Solution:

Diversion:

It has been concluded that diverting 75cfs of water toward culvert 6 is the best course of action as it affords the use of a much smaller pond than is necessary without diversion. Because there is only 0.4% grade difference between the diversion location along the existing flow path, and the inflow invert of culvert 6, it is necessary to use a concrete channel to divert the water. A concrete channel 8' wide and 2' deep accommodates the needed 75cfs.

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Detention & Diversion:

The use of a detention pond of approximately 1.5 acres, in conjunction with the diversion of 75cfs to culvert 6, is the cheapest and most efficient solution to remediate the flooding issues at Hwy 70 and allow all culverts along the flow path to pass under 50 year storm conditions. Without diverting any water away from the existing flow path, the needed pond area would consist of one 3 acre pond, and a second ½ acre pond. With use of diversion, we were able to consolidate the needed pond area to a single 1.5 acre pond placed north of Hannah Ford Rd. In order to aid in acquiring permission from the landowner to allow the placement of the pond on her property, the pond was designed as a wet pond intended for the livestock. The pond will hold a 3ft depth of water across the entire 1.5 acre pond, and when the water level rises in a storm event, the pond can hold up to 8ft of water over its entire length, and will drain slowly back to 3 ft.

Sincerely,

David Lowery

David Lowery
(615) 881-3973
loweryda@mail.lipscomb.edu

LIPSCOMB UNIVERSITY | RAYMOND B. JONES COLLEGE OF ENGINEERING

ENCLOSURE (A)

CONSTRUCTION DRAWINGS

LIPSCOMB UNIVERSITY
RAYMOND B. JONES
COLLEGE OF ENGINEERING

PEGRAM FLOOD REMEDIATION PROJECT
DESIGN DEVELOPMENT DRAWINGS – NOT FOR CONSTRUCTION

SITE LOCATION:
HIGHWAY 70 SHOPPING AREA
500 BLOCK HIGHWAY 70
PEGRAM, TN 37143

TABLE OF CONTENTS:

PRESENTED BY:
NATHAN CURTIS
CODY GLENN
DAVID LOWERY
ABBY QUEEN
CHRISTIAN REID

C 1.0
PROJ. 001
DATE 04/04/2017
COVER SHEET
NOT FOR CONSTRUCTION

CULVERT DATA ALONG FLOWPATH FOR 50 YEAR STORM – EXISTING						
CULVERT NAME	# OF CULVERTS	SIZE OF CULVERTS	CULVERT CAPACITY (CFS)	TOTAL INCOMING FLOW (CFS)	FLOW OVERTOPPING (CFS)	DEPTH OF FLOW OVERTOPPING ROAD
1	1	36X60" ELLIPTICAL	106	148	41	3 IN.
2	1	36" ROUND	68	103	34	1.8 IN.
3	3	36" ROUND	143	172	28	2.4 IN.
4	3	18X30" ELLIPTICAL	64	220	125	5 IN.

NOTES:
1. ELEVATIONS OF SURVEY BASED ON ASSUMED BENCHMARK AT ELEVATION (0,0)
2. ELEVATIONS OF HILLS NORTH OF HANNAH FORD ROAD ARE BASED ON GIS AND DO NOT CORRESPOND WITH SURVEY ELEVATIONS.
3. CULVERT CAPACITIES SHOWN IN TABLE ARE BASED ON MANNING'S EQUATION.

C 2.0

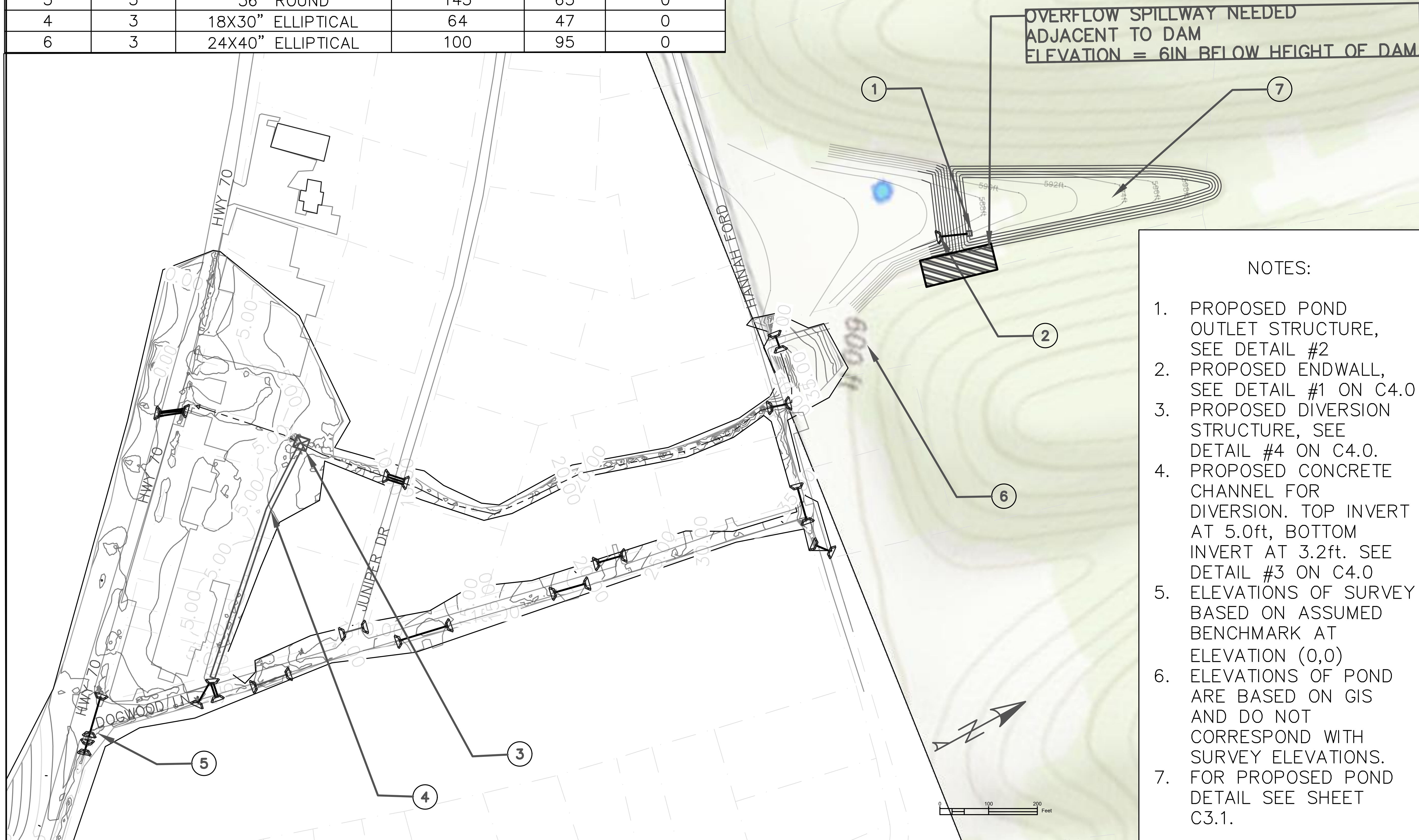
PROJ. 001

DATE 11/08/2016

EXISTING CONDITIONS

NOT FOR CONSTRUCTION

CULVERT DATA ALONG FLOWPATH FOR 50 YEAR STORM – AFTER PROPOSED CONSTRUCTION					
CULVERT NAME	# OF CULVERTS	SIZE OF CULVERTS	CULVERT CAPACITY (CFS)	TOTAL INCOMING FLOW (CFS)	FLOW OVERTOPPING (CFS)
1	1	36X60" ELLIPTICAL	106	37	0
2	1	36" ROUND	68	37	0
3	3	36" ROUND	143	65	0
4	3	18X30" ELLIPTICAL	64	47	0
6	3	24X40" ELLIPTICAL	100	95	0



NOTES:

1. PROPOSED POND OUTLET STRUCTURE, SEE DETAIL #2
2. PROPOSED ENDWALL, SEE DETAIL #1 ON C4.0
3. PROPOSED DIVERSION STRUCTURE, SEE DETAIL #4 ON C4.0.
4. PROPOSED CONCRETE CHANNEL FOR DIVERSION. TOP INVERT AT 5.0ft, BOTTOM INVERT AT 3.2ft. SEE DETAIL #3 ON C4.0
5. ELEVATIONS OF SURVEY BASED ON ASSUMED BENCHMARK AT ELEVATION (0,0)
6. ELEVATIONS OF POND ARE BASED ON GIS AND DO NOT CORRESPOND WITH SURVEY ELEVATIONS.
7. FOR PROPOSED POND DETAIL SEE SHEET C3.1.

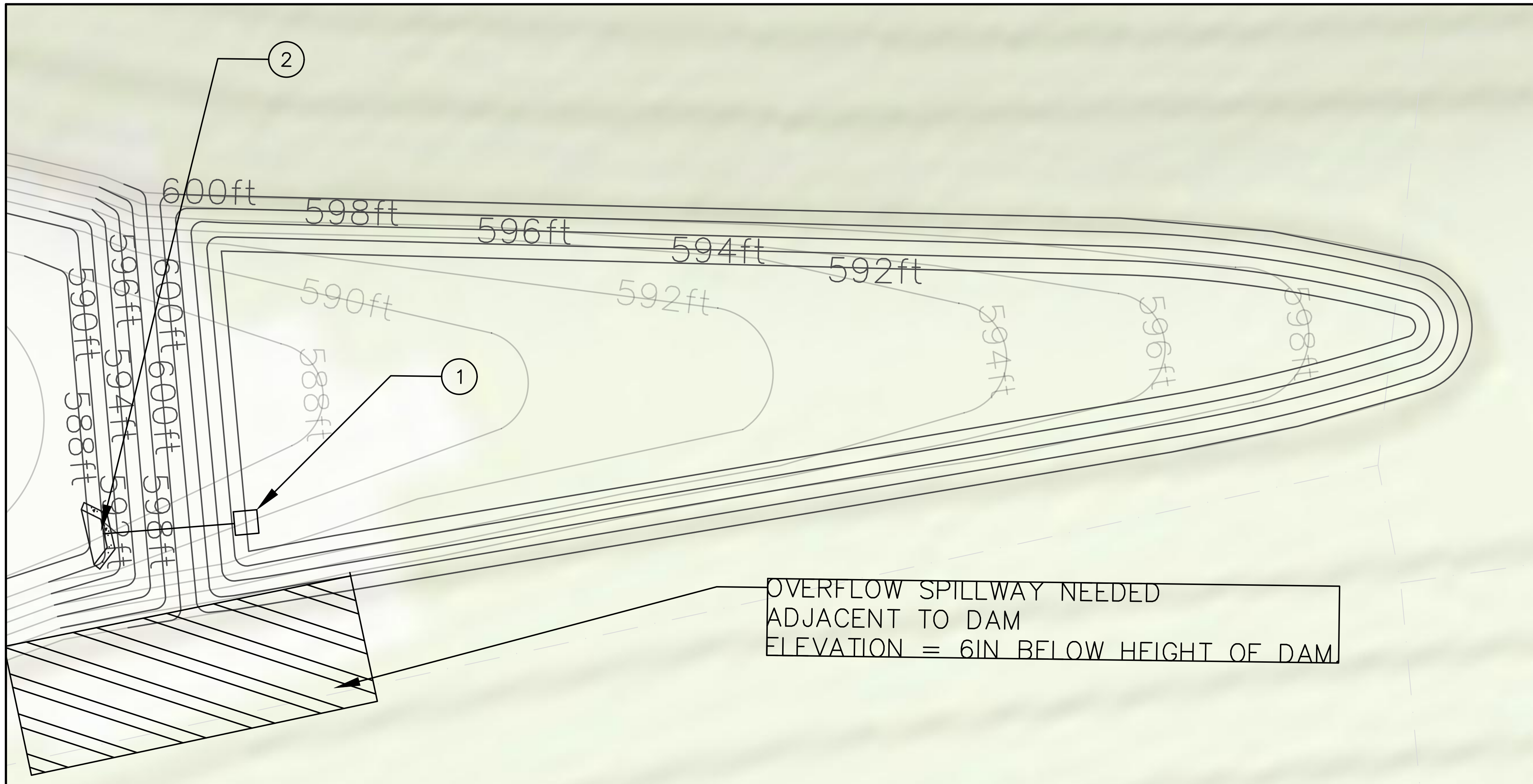
C 3.0

PROJ. 001

DATE 04/04/2017

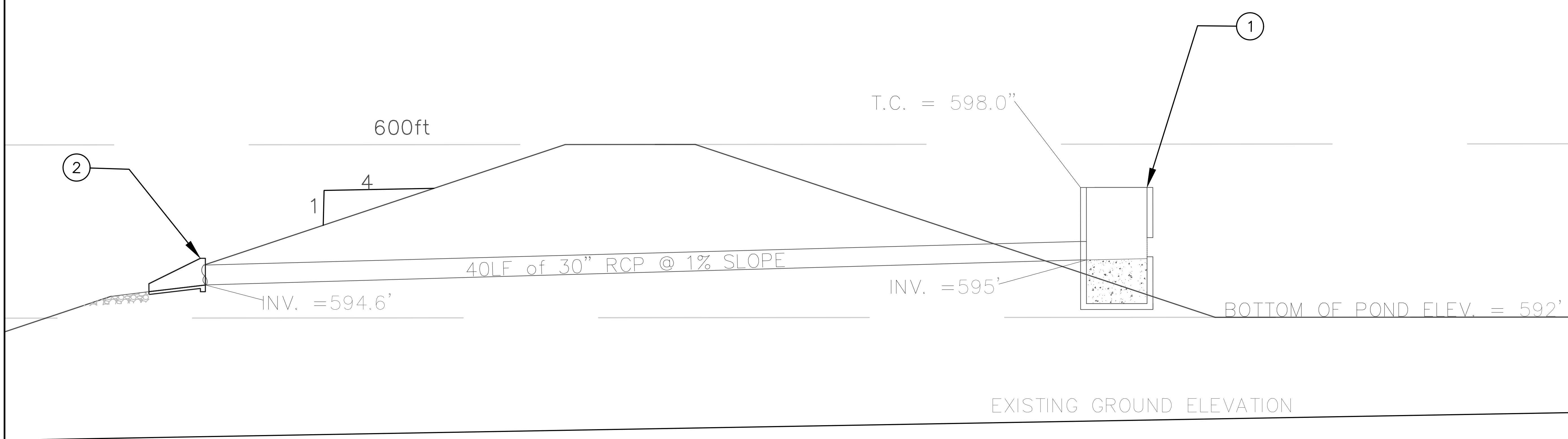
PROPOSED SITE PLAN

NOT FOR CONSTRUCTION



POND NOTES:

1. PROPOSED POND OUTLET STRUCTURE, SEE DETAIL #2 ON C4.0.
2. PROPOSED ENDWALL, SEE DETAIL #1 ON C4.0.
3. ALL TOPSOIL UNDER FOUNDATION OF DAM TO BE EXCAVATED PRIOR TO FILL.
4. ALL FILL MATERIAL FOR THE DAM TO HAVE A CLAY CONTENT EQUAL TO 15–30% BY WEIGHT AND LESS THAN 10% COARSE AGGREGATES.
5. EARTHEN DAM TO BE COMPACTED TO 95% OF STANDARD PROCTOR
6. ELEVATIONS OF POND ARE BASED ON GIS AND DO NOT CORRESPOND WITH SURVEY ELEVATIONS.



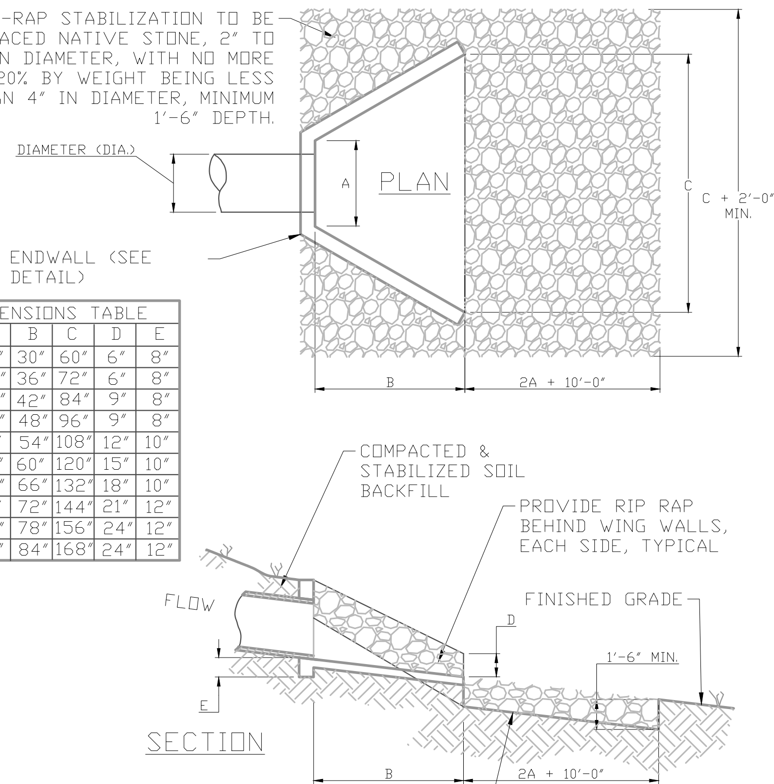
C 3.1

PROJ. 001

DATE 04/04/2017

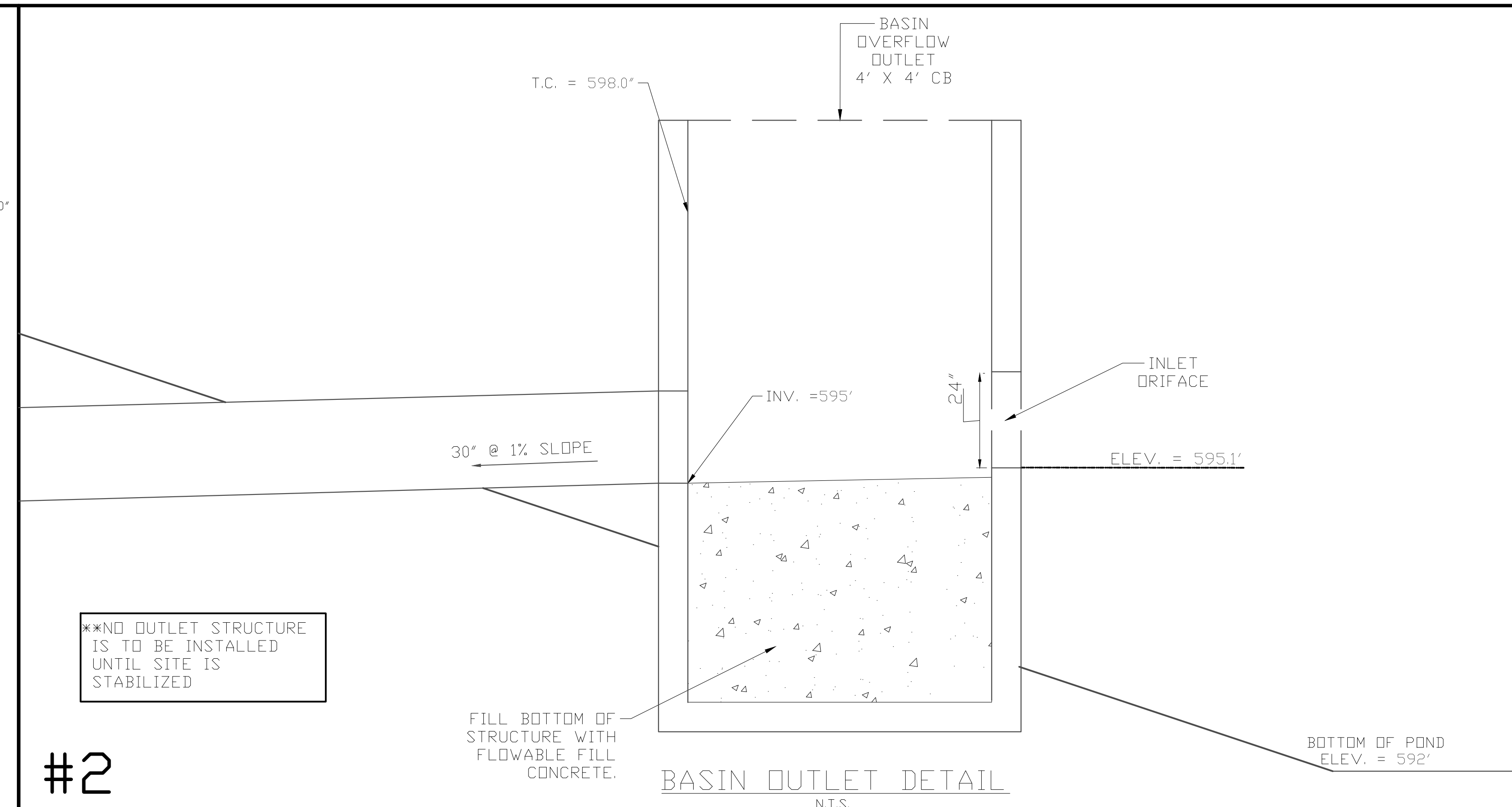
PROPOSED POND PLAN

NOT FOR CONSTRUCTION



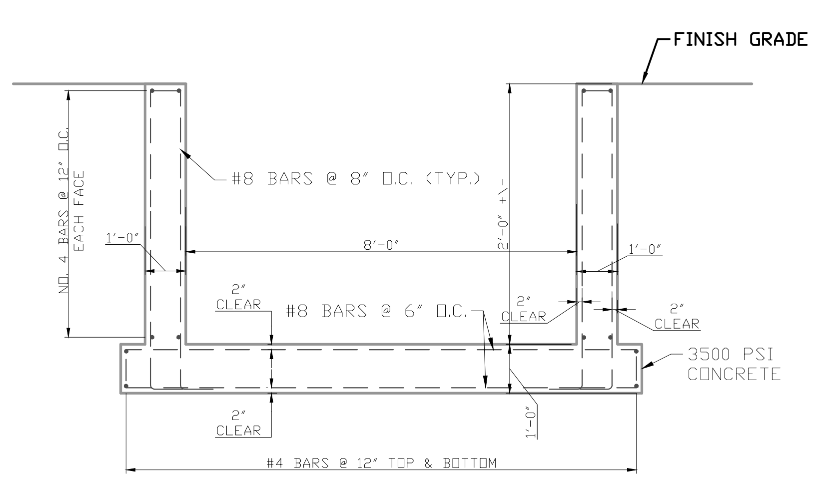
DIMENSIONS TABLE					
DIA.	A	B	C	D	E
12"	20"	30"	60"	6"	8"
15"	23"	36"	72"	6"	8"
18"	28"	42"	84"	9"	8"
24"	34"	48"	96"	9"	8"
30"	40"	54"	108"	12"	10"
36"	48"	60"	120"	15"	10"
42"	54"	66"	132"	18"	10"
48"	60"	72"	144"	21"	12"
54"	66"	78"	156"	24"	12"
60"	72"	84"	168"	24"	12"

#1 RIP RAP AT ENDWALL
N.T.S.



**NO OUTLET STRUCTURE IS TO BE INSTALLED UNTIL SITE IS STABILIZED

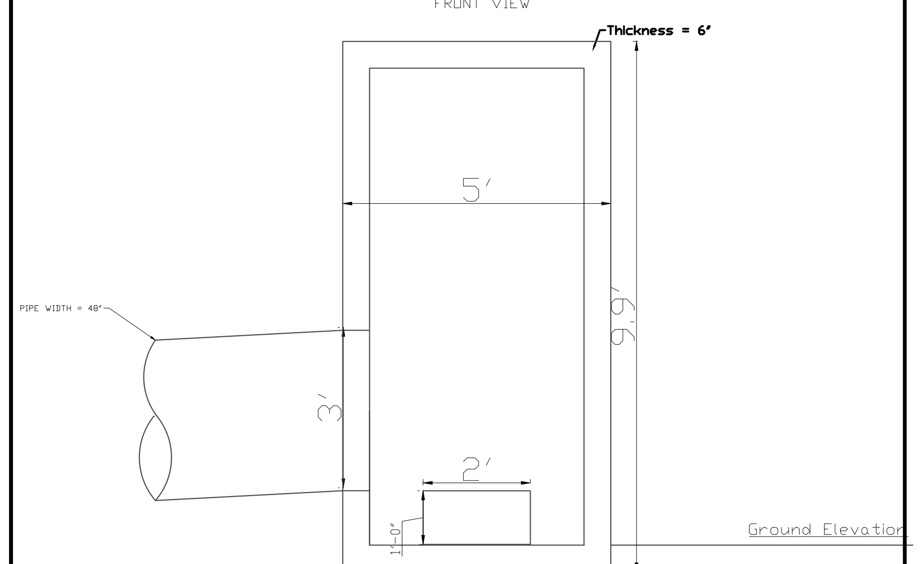
#2 BASIN OUTLET DETAIL
N.T.S.



NOTES:
1. CONCRETE TO BE CLASS "A" (CAST IN PLACE), f'c = 3500 psi.
2. REINFORCING STEEL TO BE ASTM A615, GRADE 60.
3. STANDARD CRSI DETAILS APPLY UNLESS OTHERWISE NOTED.
4. WALLS TO BE REINFORCED W/#4 BARS @ 8" VERTICALLY AND #4 BARS @ 1'-0" HORIZONTALLY, EACH FACE.
5. USE COMPACTED SUBGRADE AGGREGATE TO MEET TDOT SPECIFICATIONS.
6. THIS IS A CONCRETE CHANNEL, THE TOP WILL BE OPEN TO THE AIR.

#3 CONCRETE CHANNEL
N.T.S.

FRONT VIEW



NOTES:
1. CONCRETE TO BE CLASS "A" (CAST IN PLACE), f'c = 3500 psi.
2. REINFORCING STEEL TO BE ASTM A615, GRADE 60.
3. STANDARD CRSI DETAILS APPLY UNLESS OTHERWISE NOTED.
4. WALLS TO BE REINFORCED W/#4 BARS @ 8" VERTICALLY AND #4 BARS.

#4 CONCRETE DIVERSION STRUCTURE
N.T.S.

C 4.0
PROJ. 001
DATE 04/04/2017
DETAILS SHEET
NOT FOR CONSTRUCTION

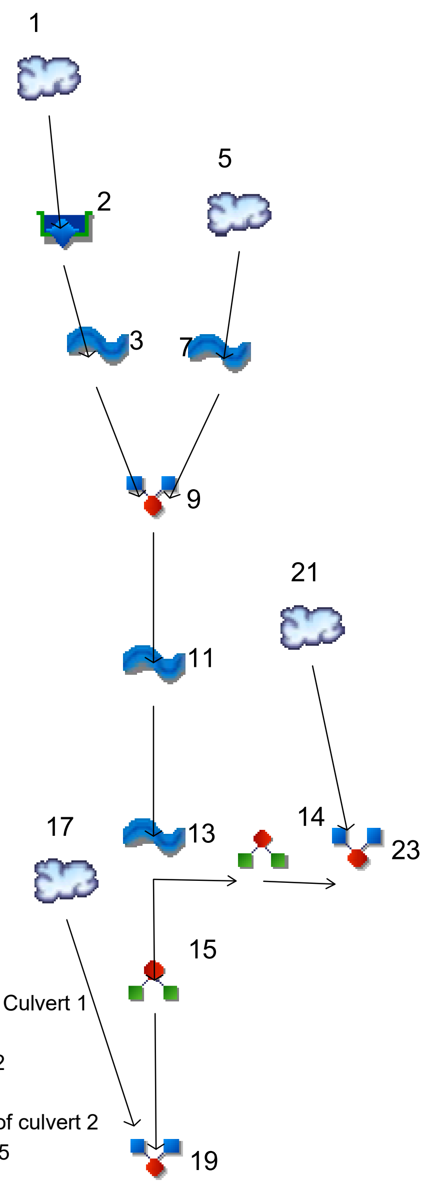
LIPSCOMB UNIVERSITY | RAYMOND B. JONES COLLEGE OF ENGINEERING

ENCLOSURE (B)

HYDROLOGY REPORT

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Area Above Hannah Ford leading to Culvert 1
2	Reservoir	Pond
3	Reach	Ditch between Culvert 1 and culver 2
5	SCS Runoff	Area above culvert 5 to culvert 5
7	Reach	Ditch between culvert 5 and outfall of culvert 2
9	Combine	Junction of ditches for culvert 2 and 5
11	Reach	Ditch betweenn culverts 2 and 3
13	Reach	Channel Between Culvert 3 and 4
14	Diversion1	TO CUlvert 6
15	Diversion2	To HWY 70
17	SCS Runoff	Sheet flow from houses to hwy 70
19	Combine	Flow at culverts hwy 70
21	SCS Runoff	Flow to culvert 6
23	Combine	Culvert 6 inflow

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	19.31	1	739	153,782	------	------	------	Area Above Hannah Ford leading to
2	Reservoir	0.481	1	1470	13,393	1	38.37	151,119	Pond
3	Reach	0.481	1	1472	13,390	2	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	11.25	1	725	42,927	------	------	------	Area above culvert 5 to culvert 5
7	Reach	11.24	1	726	42,926	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	11.24	1	726	56,316	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	10.35	1	730	56,305	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	9.930	1	733	56,296	11	------	------	Channel Between Culvert 3 and 4
14	Diversion1	9.930	1	733	56,296	13	------	------	TO CUlvert 6
15	Diversion2	0.000	1	n/a	0	13	------	------	To HWY 70
17	SCS Runoff	12.98	1	739	71,713	------	------	------	Sheet flow from houses to hwy 70
19	Combine	12.98	1	739	71,713	15, 17,	------	------	Flow at culverts hwy 70
21	SCS Runoff	6.184	1	725	19,948	------	------	------	Flow to culvert 6
23	Combine	14.51	1	731	76,244	14, 21,	------	------	Culvert 6 inflow

Diversion analysis with 1 pond (1).gpw	Return Period: 2 Year	Tuesday, 03 / 28 / 2017

Hydrograph Report

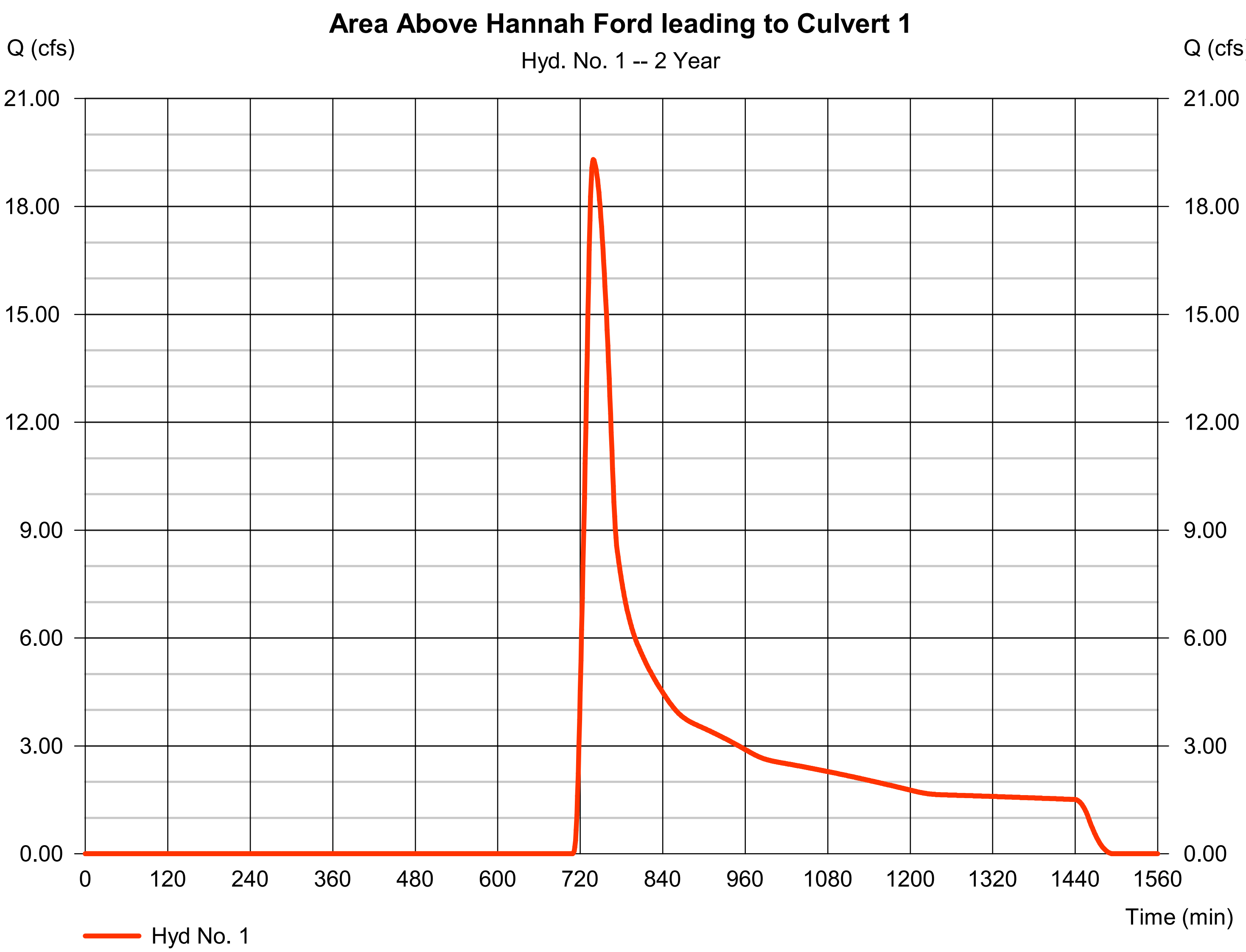
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 19.31 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 153,782 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



TR55 Tc Worksheet

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.400		0.050		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		3.62		3.62		
Land slope (%)	=	5.00		0.00		0.00		
Travel Time (min)	**=**	**19.36**	**+**	**0.00**	**+**	**0.00**	**=**	**19.36**
Shallow Concentrated Flow								
Flow length (ft)	=	1610.00		0.00		0.00		
Watercourse slope (%)	=	4.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.23			0.00		0.00		
Travel Time (min)	**=**	**8.32**	**+**	**0.00**	**+**	**0.00**	**=**	**8.32**
Channel Flow								
X sectional flow area (sqft)	=	12.00		0.00		0.00		
Wetted perimeter (ft)	=	8.00		0.00		0.00		
Channel slope (%)	=	2.00		0.00		0.00		
Manning's n-value	=	0.050		0.015		0.015		
Velocity (ft/s)	=5.53							
				0.00				
						0.00		
Flow length (ft)	({0})2346.0			0.0		0.0		
Travel Time (min)	**=**	**7.07**	**+**	**0.00**	**+**	**0.00**	**=**	**7.07**

Total Travel Time, Tc .... **34.70 min**

Hydrograph Report

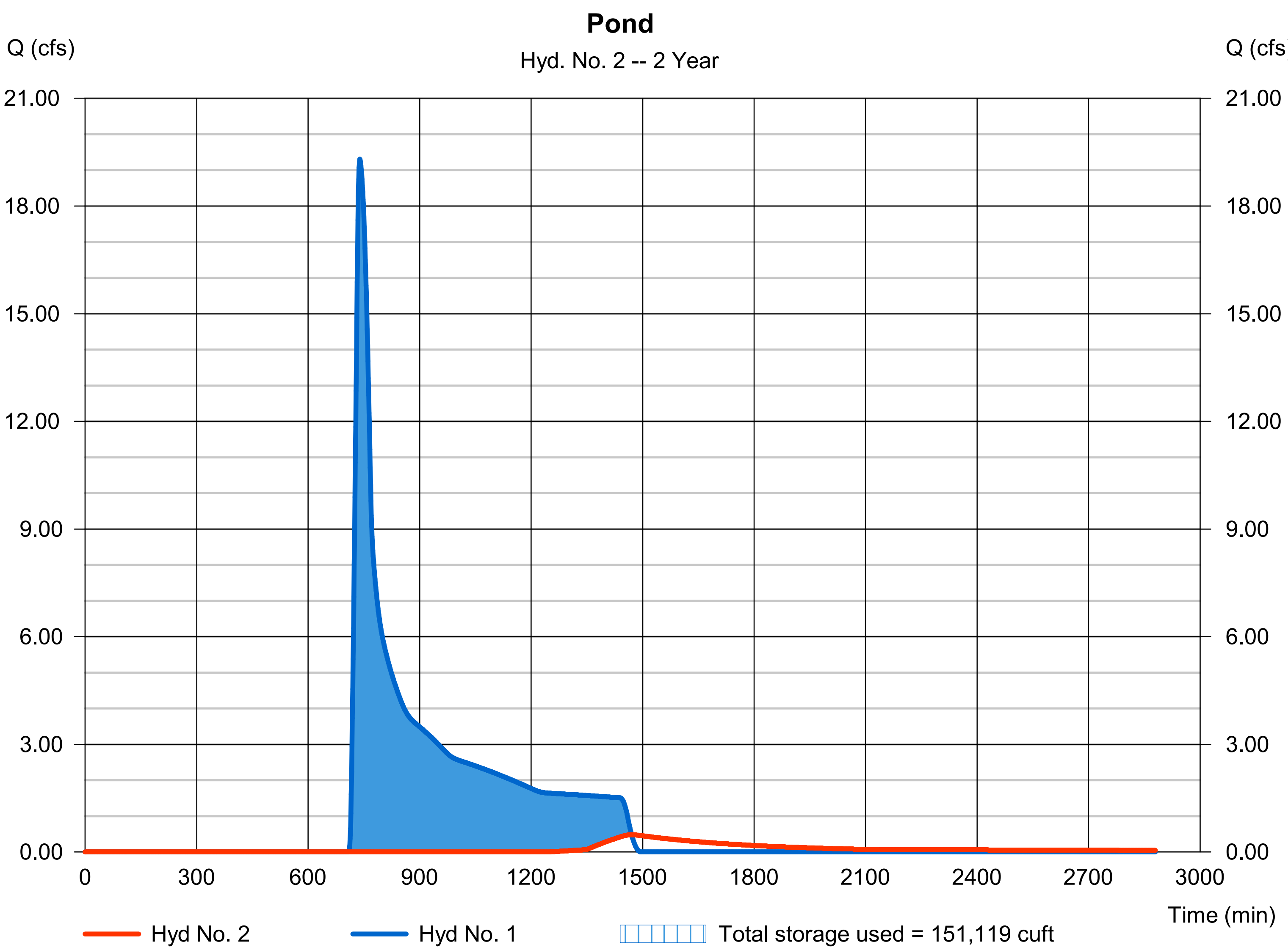
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 2

Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.481 cfs
Storm frequency	= 2 yrs	Time to peak	= 1470 min
Time interval	= 1 min	Hyd. volume	= 13,393 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Max. Elevation	= 38.37 ft
Reservoir name	= Pond Paired with Diversion	Max. Storage	= 151,119 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Pond No. 1 - Pond Paired with Diversion

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 35.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	35.00	38,532	0	0
2.00	37.00	45,517	83,944	83,944
4.00	39.00	52,844	98,260	182,204
6.00	41.00	60,287	113,038	295,242
8.00	43.00	67,801	128,002	423,243

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	24.00	0.00	0.00
Span (in)	= 30.00	24.00	0.00	0.00
No. Barrels	= 2	1	0	0
Invert El. (ft)	= 38.00	38.10	0.00	0.00
Length (ft)	= 50.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 4.00	3.00	0.00	0.00
Crest El. (ft)	= 42.50	42.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	Yes	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	35.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	83,944	37.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
4.00	182,204	39.00	4.42 ic	4.40 ic	---	---	0.00	0.00	---	---	---	---	4.398
6.00	295,242	41.00	20.11 ic	19.78 ic	---	---	0.00	0.00	---	---	---	---	19.78
8.00	423,243	43.00	39.47 oc	24.77 ic	---	---	4.71	9.99	---	---	---	---	39.47

Hydrograph Report

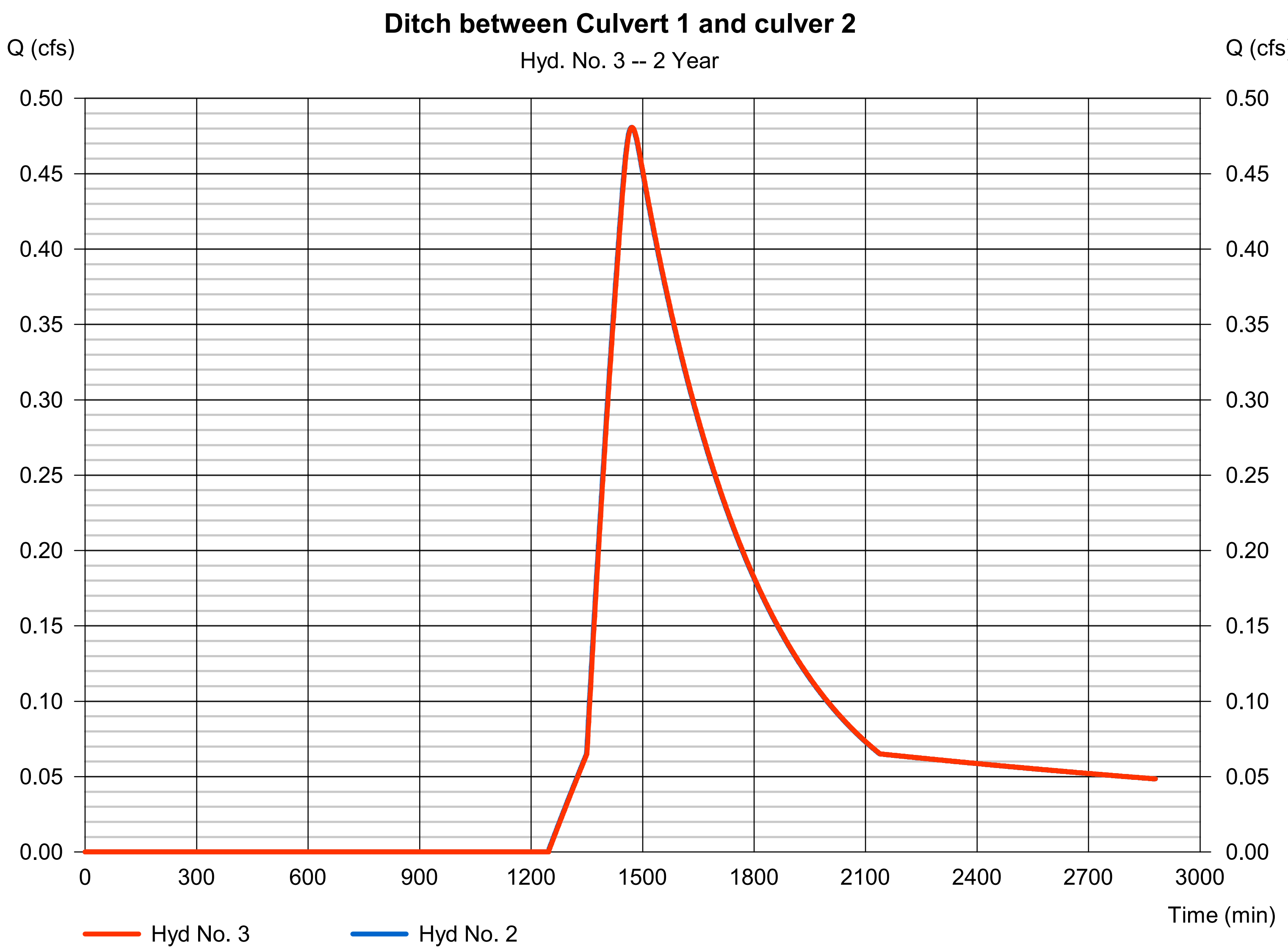
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 0.481 cfs
Storm frequency	= 2 yrs	Time to peak	= 1472 min
Time interval	= 1 min	Hyd. volume	= 13,390 cuft
Inflow hyd. No.	= 2 - Pond	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.8155

Modified Att-Kin routing method used.



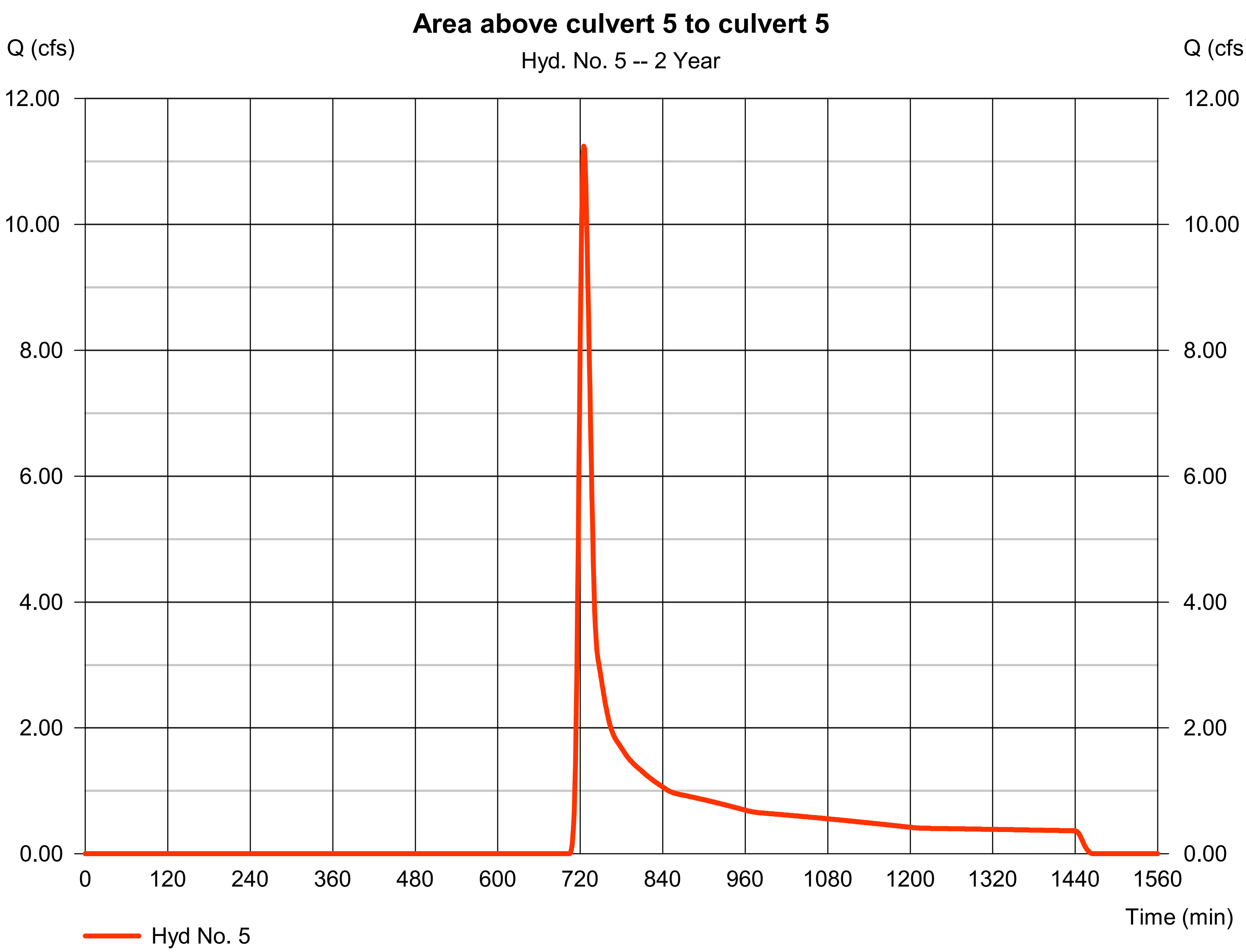
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 11.25 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 42,927 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 5

Area above culvert 5 to culvert 5

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.400		0.011		0.011		
Flow length (ft)	= 150.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.62		0.00		0.00		
Land slope (%)	= 14.00		0.00		0.00		
Travel Time (min)	**= 12.82**	**+**	**0.00**	**+**	**0.00**	**=**	**12.82**
Shallow Concentrated Flow							
Flow length (ft)	= 1350.00		0.00		0.00		
Watercourse slope (%)	= 12.50		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=5.70		0.00		0.00		
Travel Time (min)	**= 3.94**	**+**	**0.00**	**+**	**0.00**	**=**	**3.94**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 16.77 min

Hydrograph Report

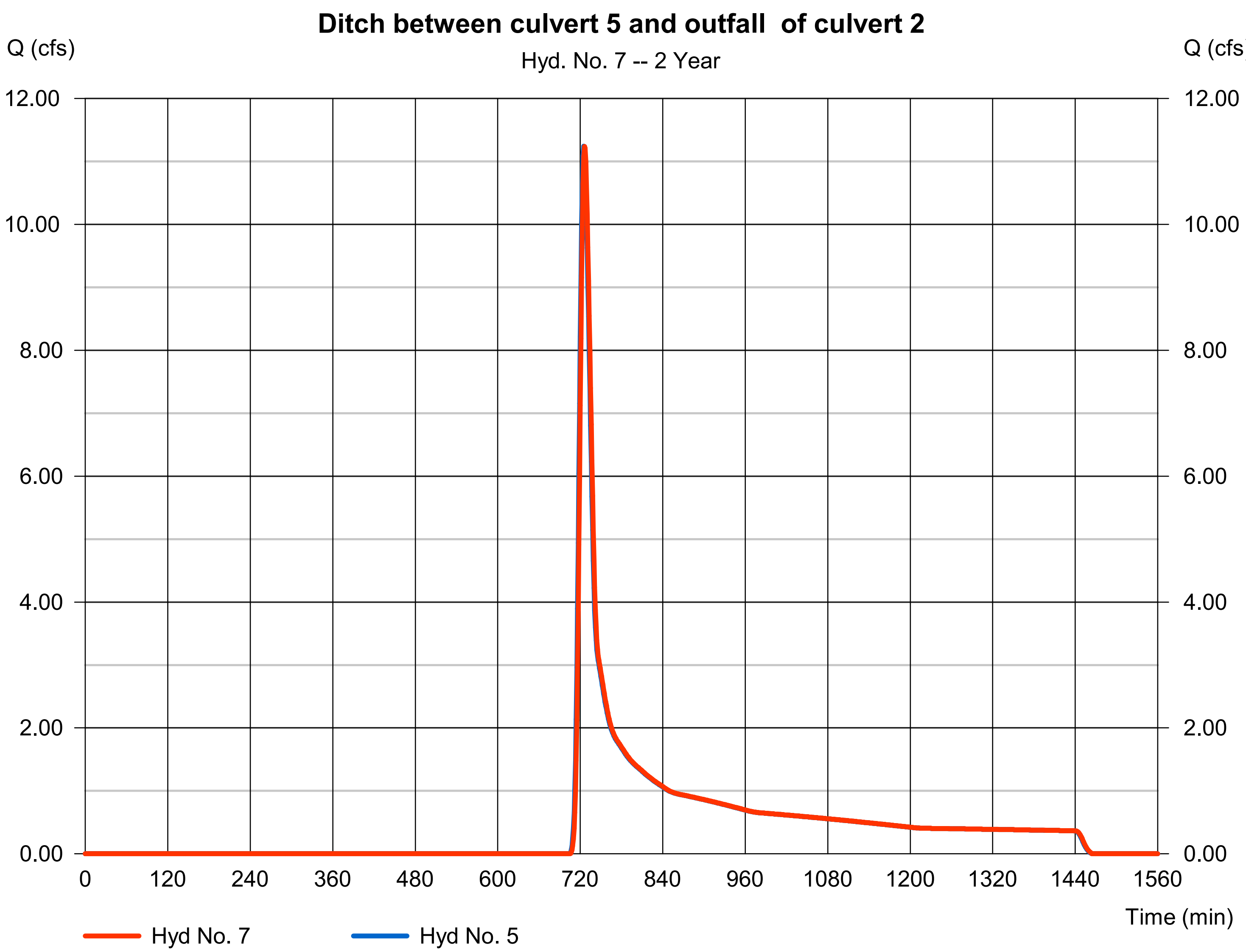
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 11.24 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 42,926 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.9741

Modified Att-Kin routing method used.



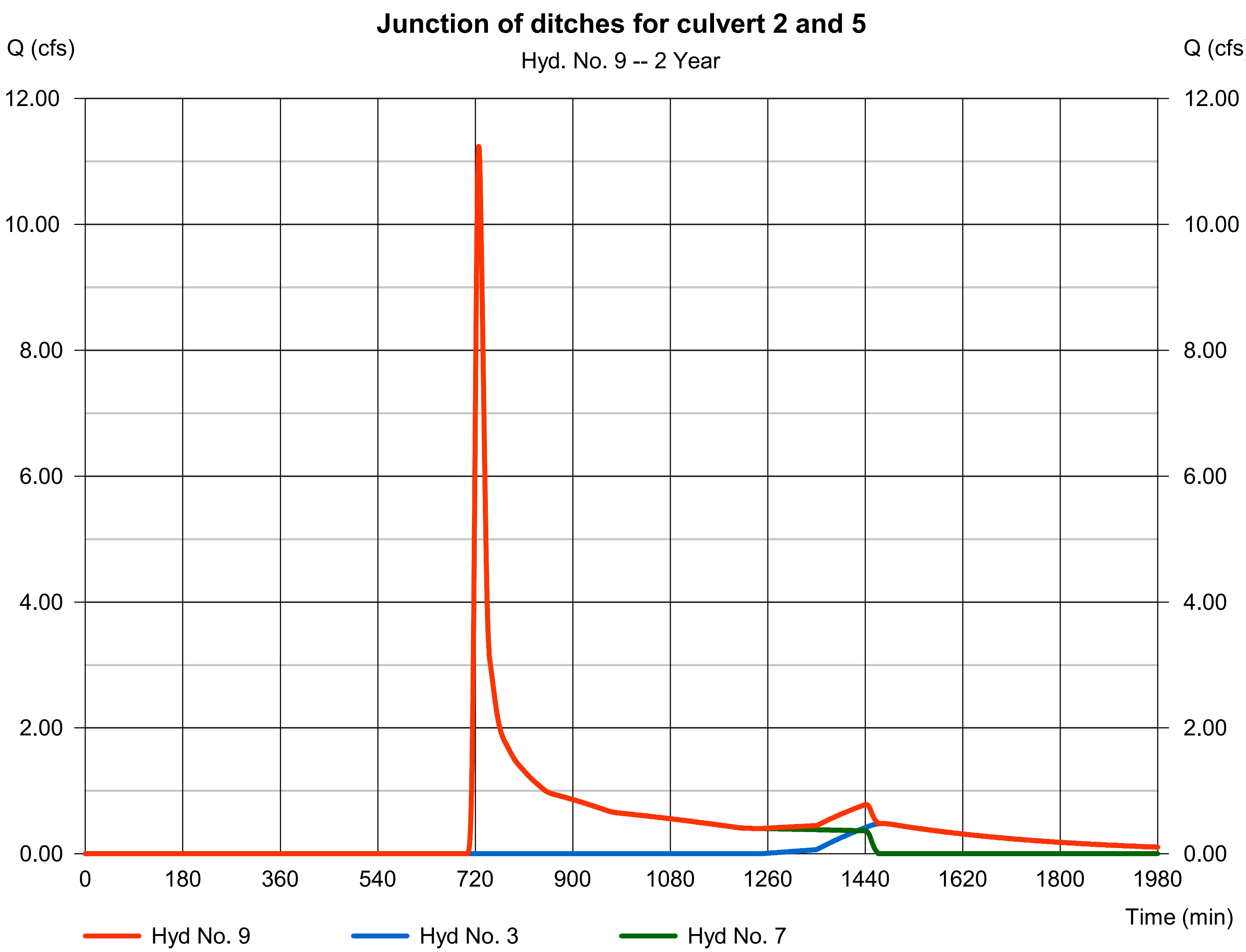
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 | Tuesday, 03 / 28 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 11.24 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 56,316 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

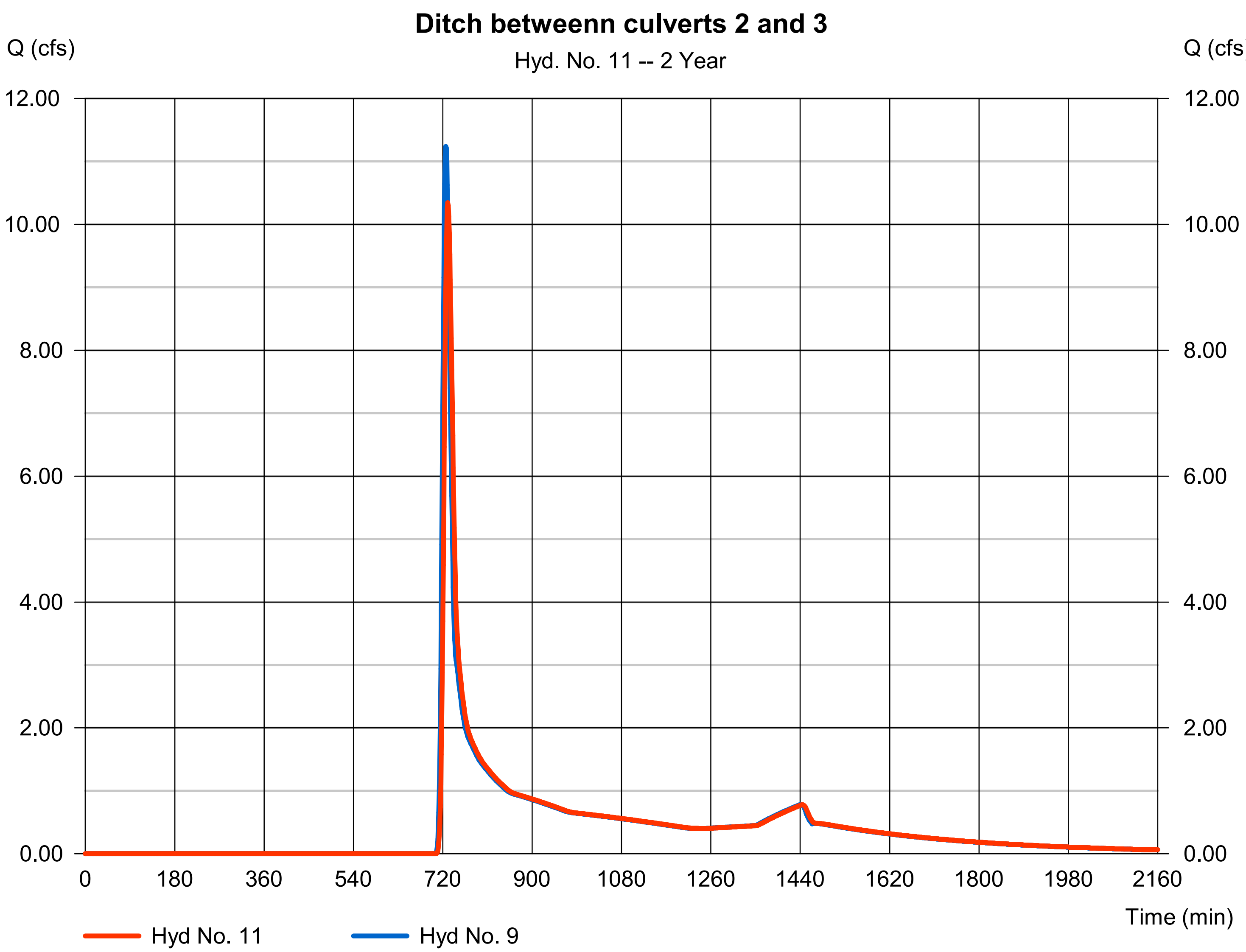
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 10.35 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 56,305 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.2597

Modified Att-Kin routing method used.



Hydrograph Report

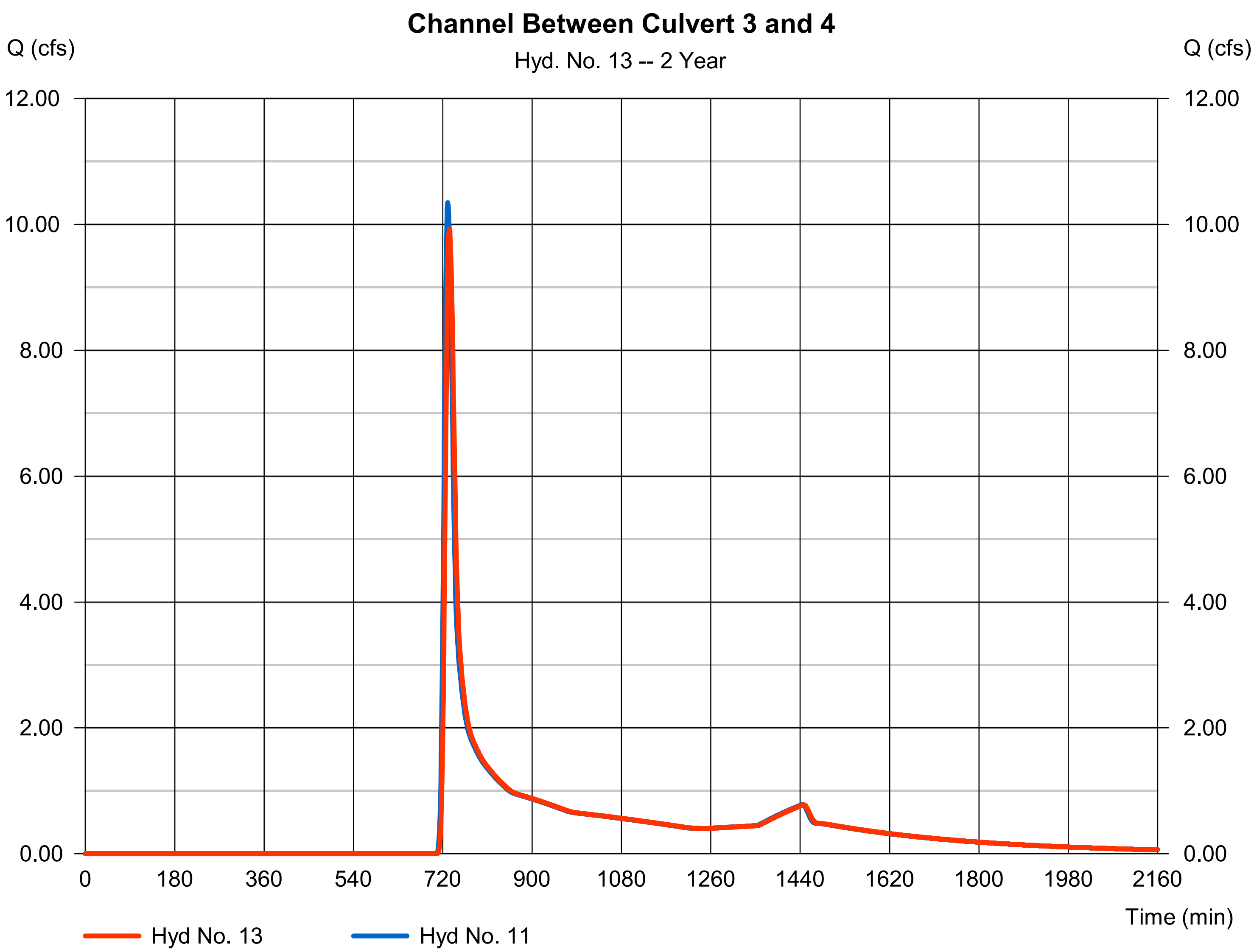
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 9.930 cfs
Storm frequency	= 2 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 56,296 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.3331

Modified Att-Kin routing method used.



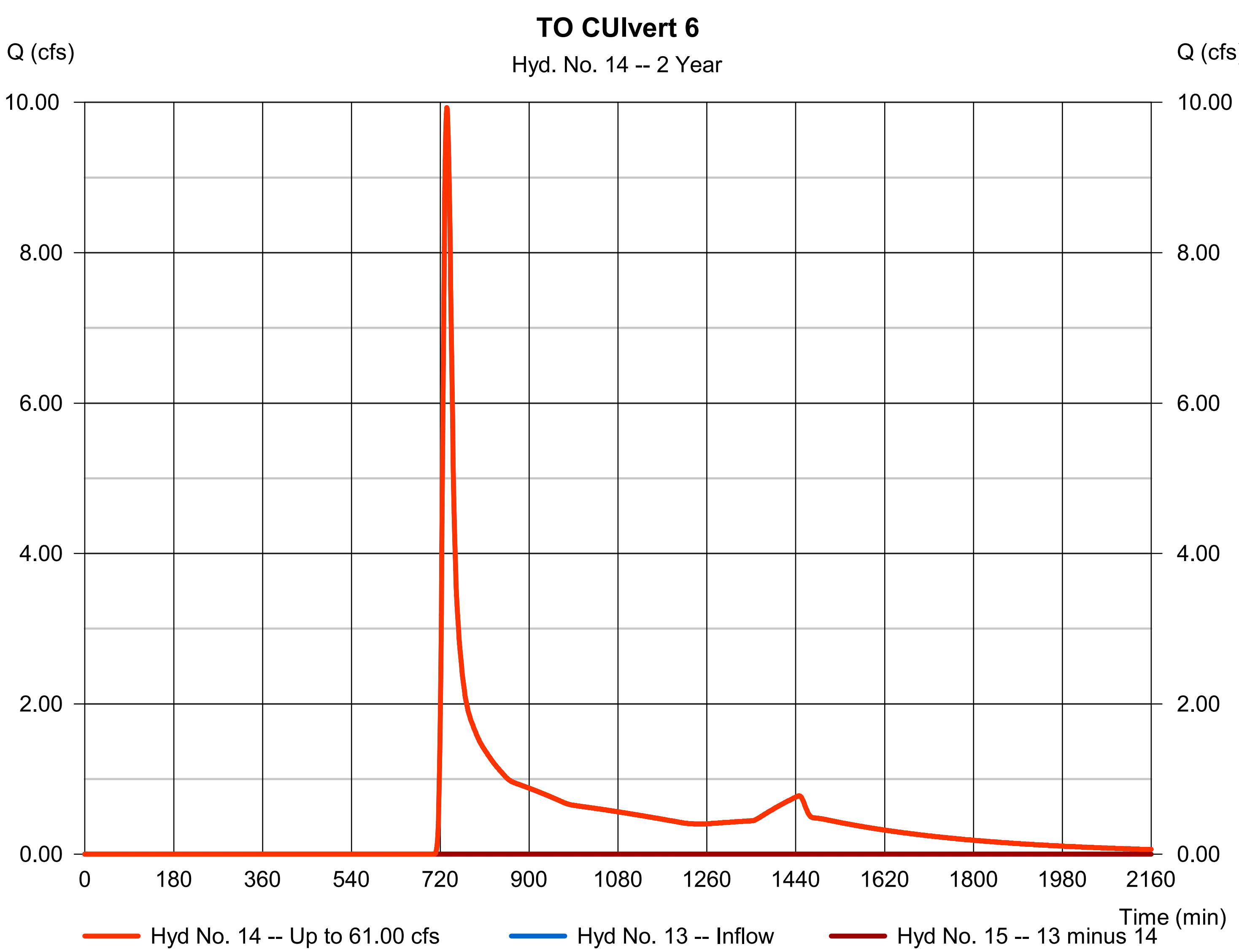
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 14

TO CUlvert 6

Hydrograph type	= Diversion1	Peak discharge	= 9.930 cfs
Storm frequency	= 2 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 56,296 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	Diverted hyd.	= 15
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



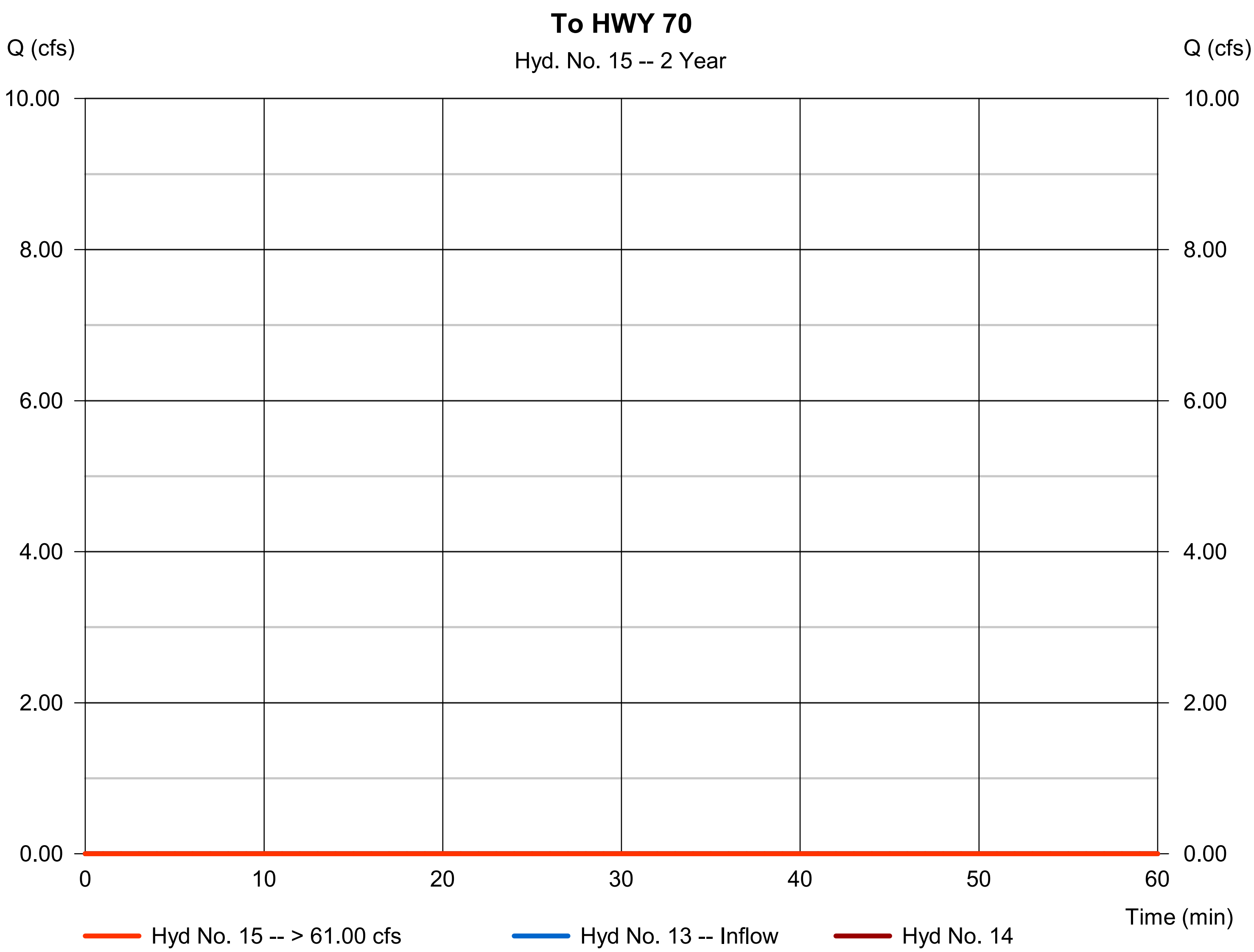
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 15

To HWY 70

Hydrograph type	= Diversion2	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 14
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



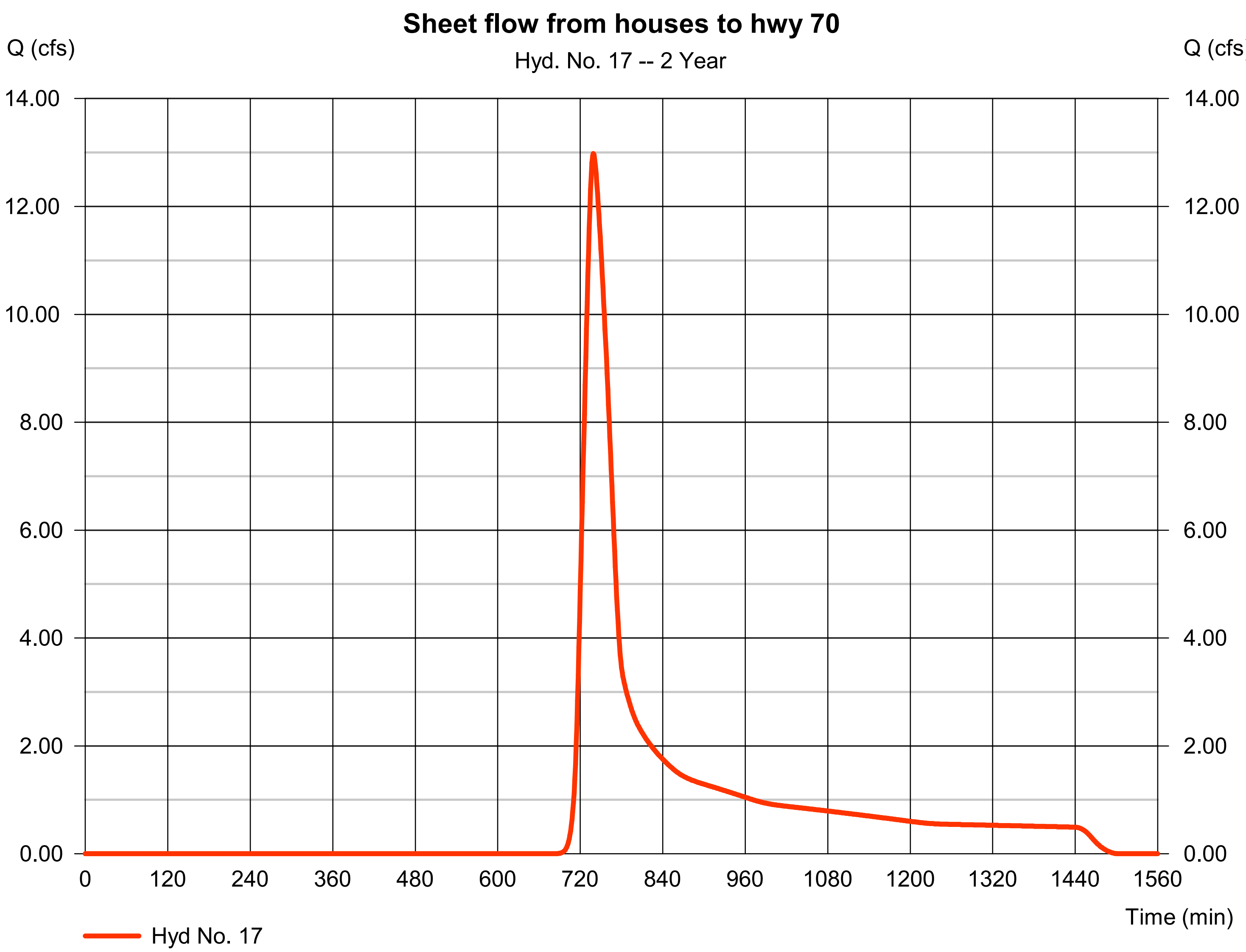
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 17

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 12.98 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 71,713 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.63 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 17

Sheet flow from houses to hwy 70

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.011		0.011		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		0.00		0.00		
Land slope (%)	=	2.00		0.00		0.00		
Travel Time (min)	**=**	**27.93**	**+**	**0.00**	**+**	**0.00**	**=**	**27.93**
Shallow Concentrated Flow								
Flow length (ft)	=	1602.00		0.00		0.00		
Watercourse slope (%)	=	2.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.28			0.00		0.00		
Travel Time (min)	**=**	**11.70**	**+**	**0.00**	**+**	**0.00**	**=**	**11.70**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **39.63 min**

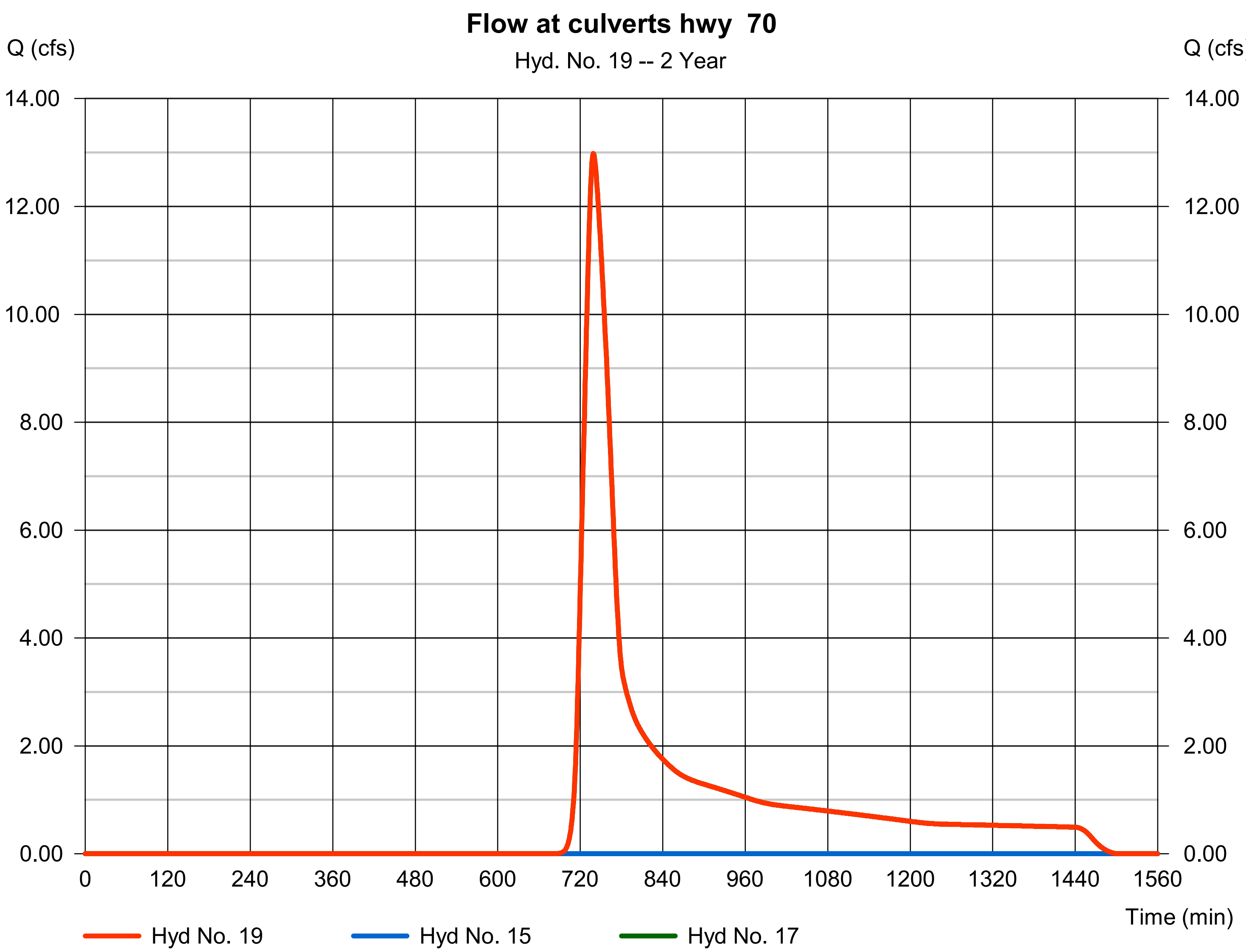
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 19

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 12.98 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 71,713 cuft
Inflow hyds.	= 15, 17	Contrib. drain. area	= 20.330 ac



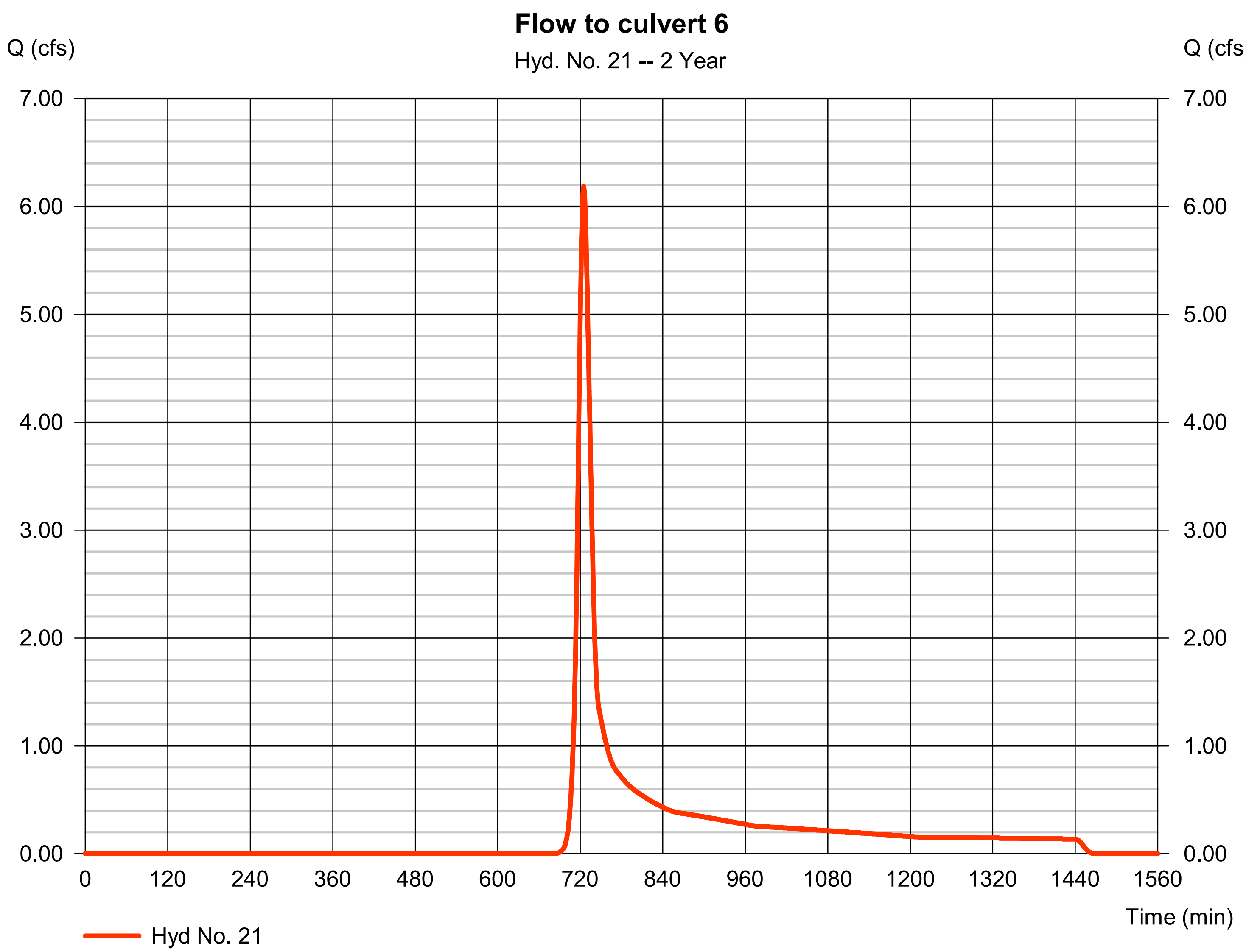
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 21

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 6.184 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 19,948 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 3.62 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 21

Flow to culvert 6

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	150.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.62		0.00		0.00		
Land slope (%)	=	2.70		0.00		0.00		
Travel Time (min)	**=**	**11.30**	**+**	**0.00**	**+**	**0.00**	**=**	**11.30**
Shallow Concentrated Flow								
Flow length (ft)	=	1030.00		0.00		0.00		
Watercourse slope (%)	=	2.70		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.65			0.00		0.00		
Travel Time (min)	**=**	**6.48**	**+**	**0.00**	**+**	**0.00**	**=**	**6.48**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **17.80 min**

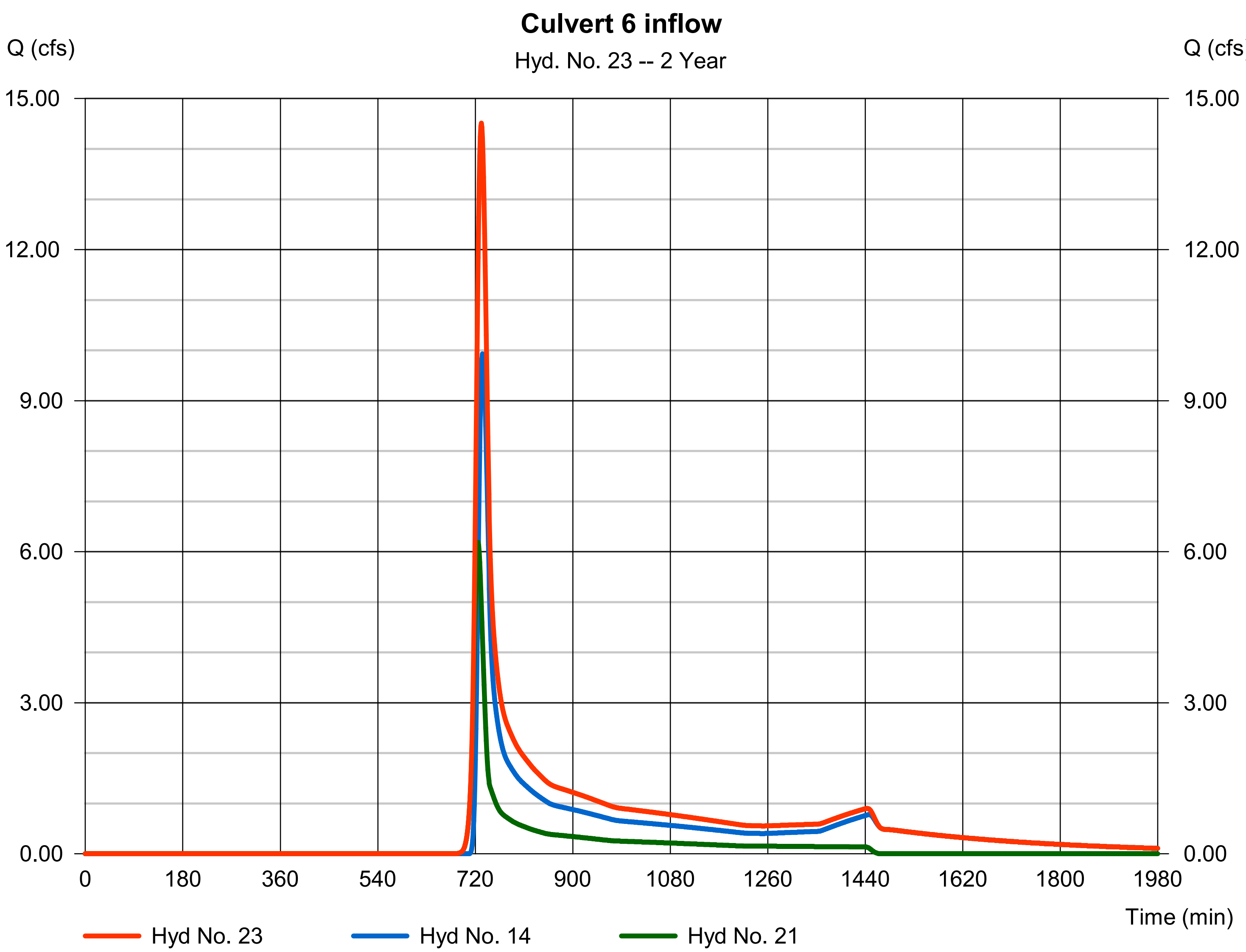
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 23

Culvert 6 inflow

Hydrograph type	= Combine	Peak discharge	= 14.51 cfs
Storm frequency	= 2 yrs	Time to peak	= 731 min
Time interval	= 1 min	Hyd. volume	= 76,244 cuft
Inflow hyds.	= 14, 21	Contrib. drain. area	= 5.720 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	44.33	1	737	273,458	------	------	------	Area Above Hannah Ford leading to
2	Reservoir	3.563	1	1078	132,237	1	38.89	177,037	Pond
3	Reach	3.563	1	1079	132,234	2	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	21.71	1	724	71,414	------	------	------	Area above culvert 5 to culvert 5
7	Reach	21.72	1	725	71,413	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	21.72	1	725	203,647	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	20.44	1	729	203,636	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	19.82	1	731	203,628	11	------	------	Channel Between Culvert 3 and 4
14	Diversion1	19.82	1	731	203,628	13	------	------	TO CUlvert 6
15	Diversion2	0.000	1	n/a	0	13	------	------	To HWY 70
17	SCS Runoff	20.93	1	738	108,627	------	------	------	Sheet flow from houses to hwy 70
19	Combine	20.93	1	738	108,627	15, 17,	------	------	Flow at culverts hwy 70
21	SCS Runoff	9.799	1	725	30,216	------	------	------	Flow to culvert 6
23	Combine	27.66	1	730	233,843	14, 21,	------	------	Culvert 6 inflow

Diversion analysis with 1 pond (1).gpw	Return Period: 5 Year	Tuesday, 03 / 28 / 2017

Hydrograph Report

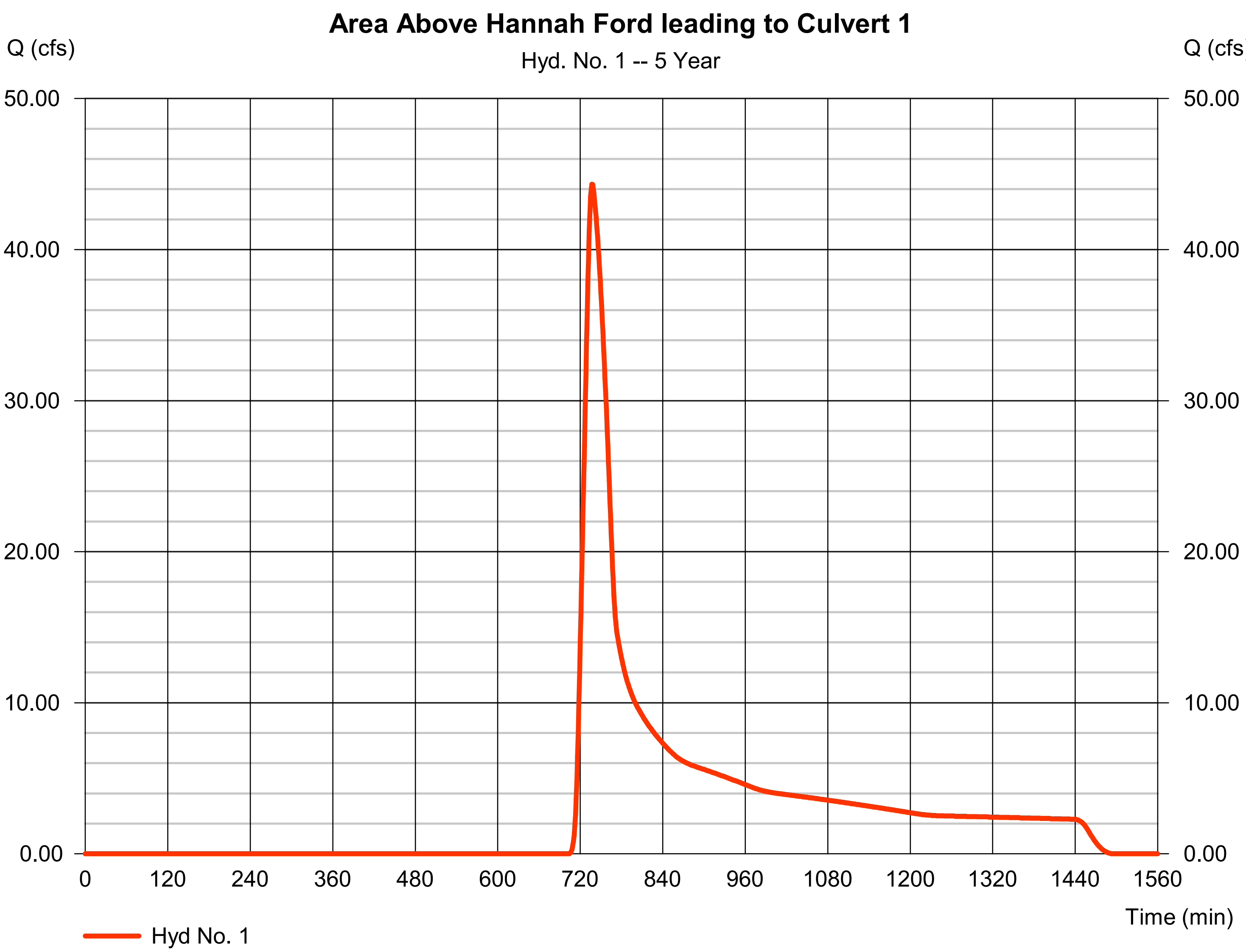
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 44.33 cfs
Storm frequency	= 5 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 273,458 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

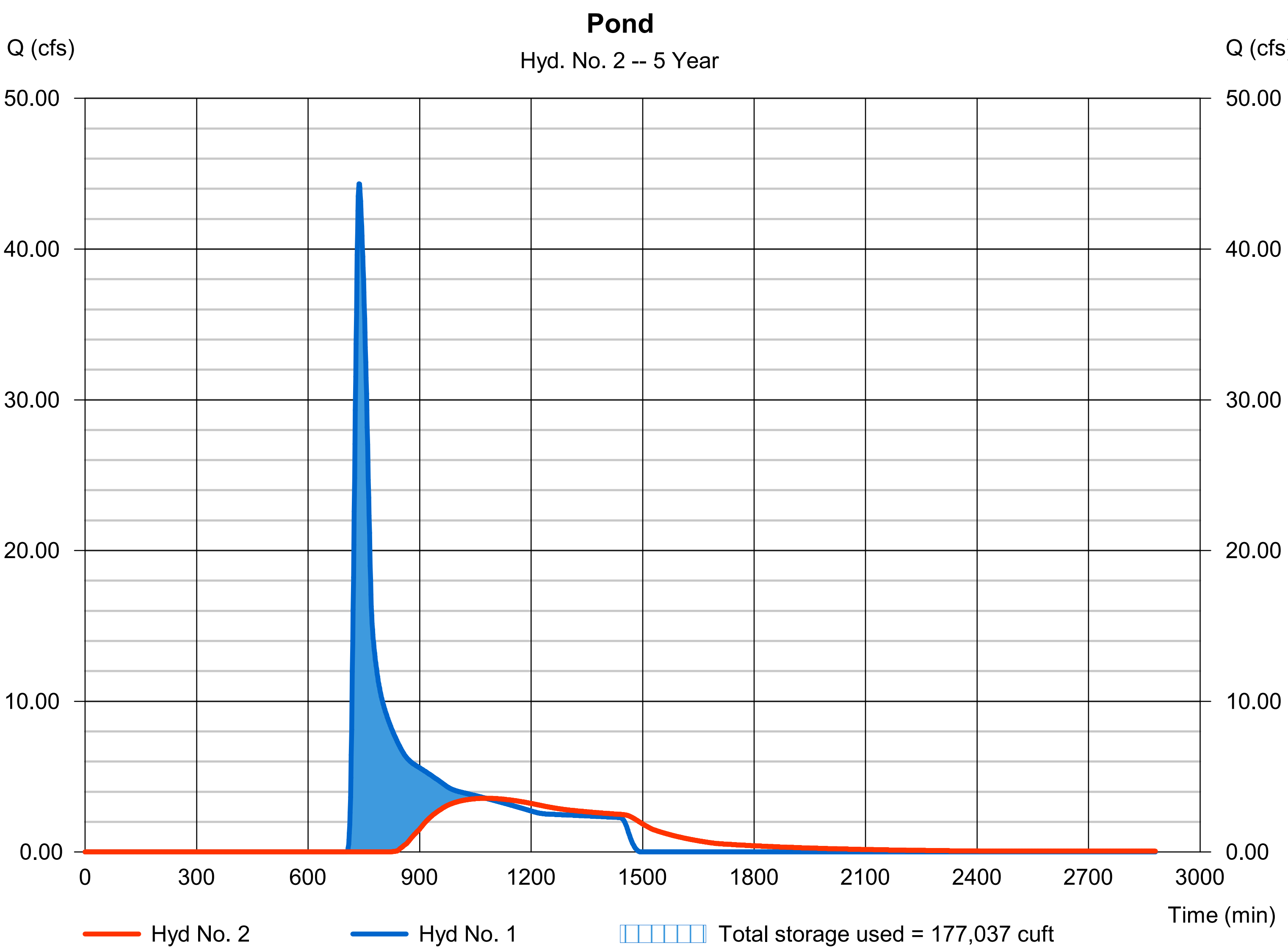
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 2

Pond

Hydrograph type	= Reservoir	Peak discharge	= 3.563 cfs
Storm frequency	= 5 yrs	Time to peak	= 1078 min
Time interval	= 1 min	Hyd. volume	= 132,237 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Max. Elevation	= 38.89 ft
Reservoir name	= Pond Paired with Diversion	Max. Storage	= 177,037 cuft

Storage Indication method used.



Hydrograph Report

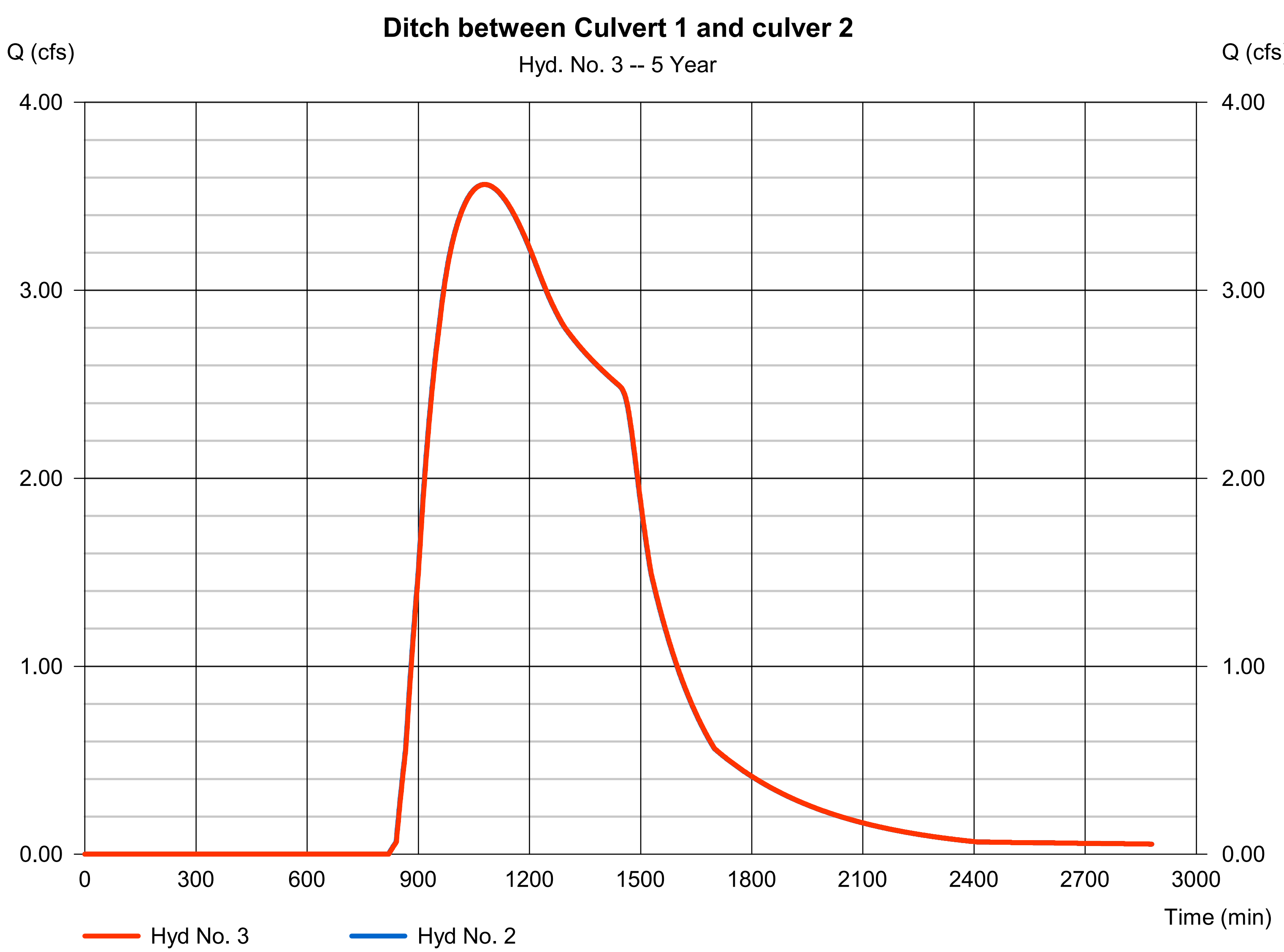
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 3.563 cfs
Storm frequency	= 5 yrs	Time to peak	= 1079 min
Time interval	= 1 min	Hyd. volume	= 132,234 cuft
Inflow hyd. No.	= 2 - Pond	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.0319

Modified Att-Kin routing method used.



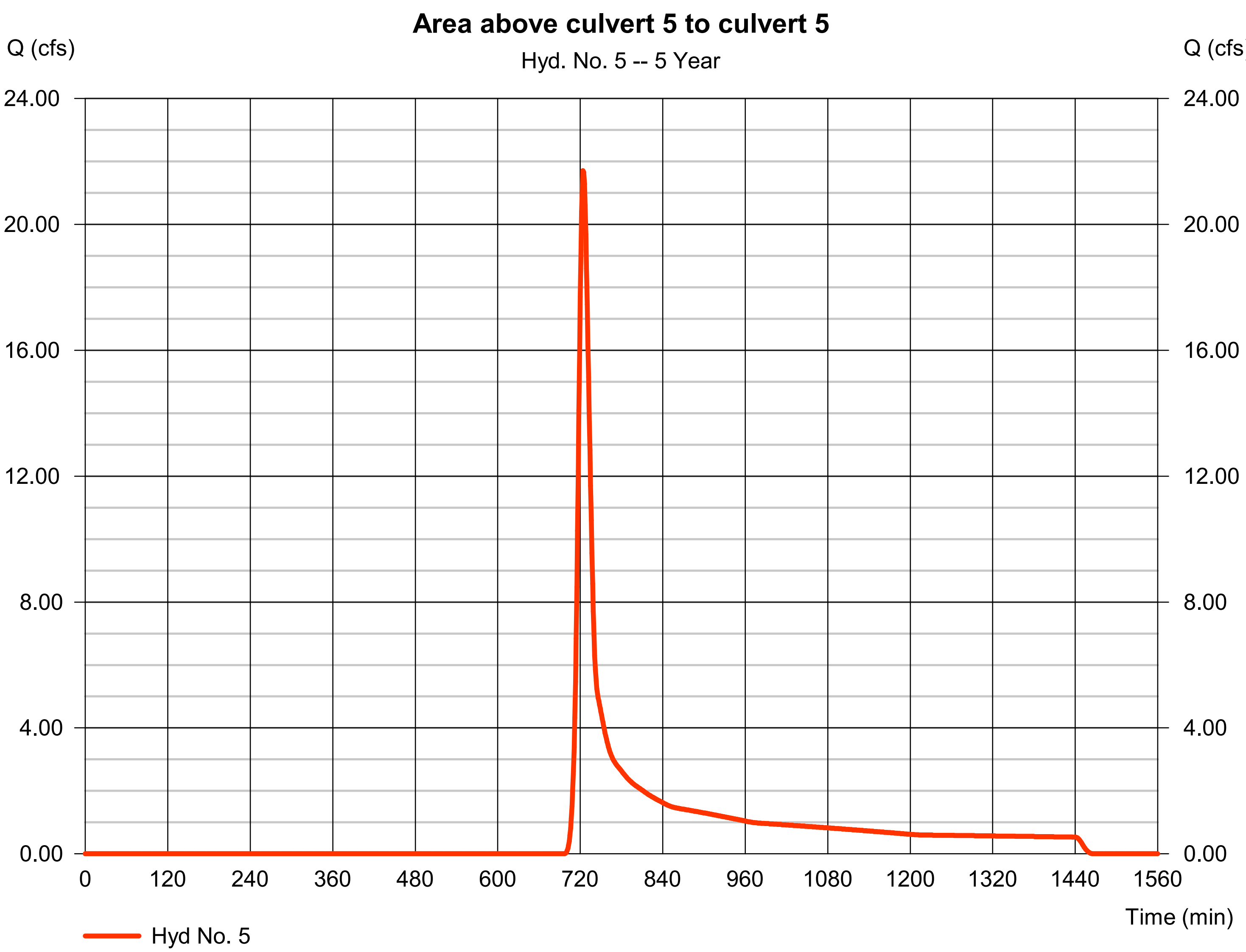
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 21.71 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 71,414 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

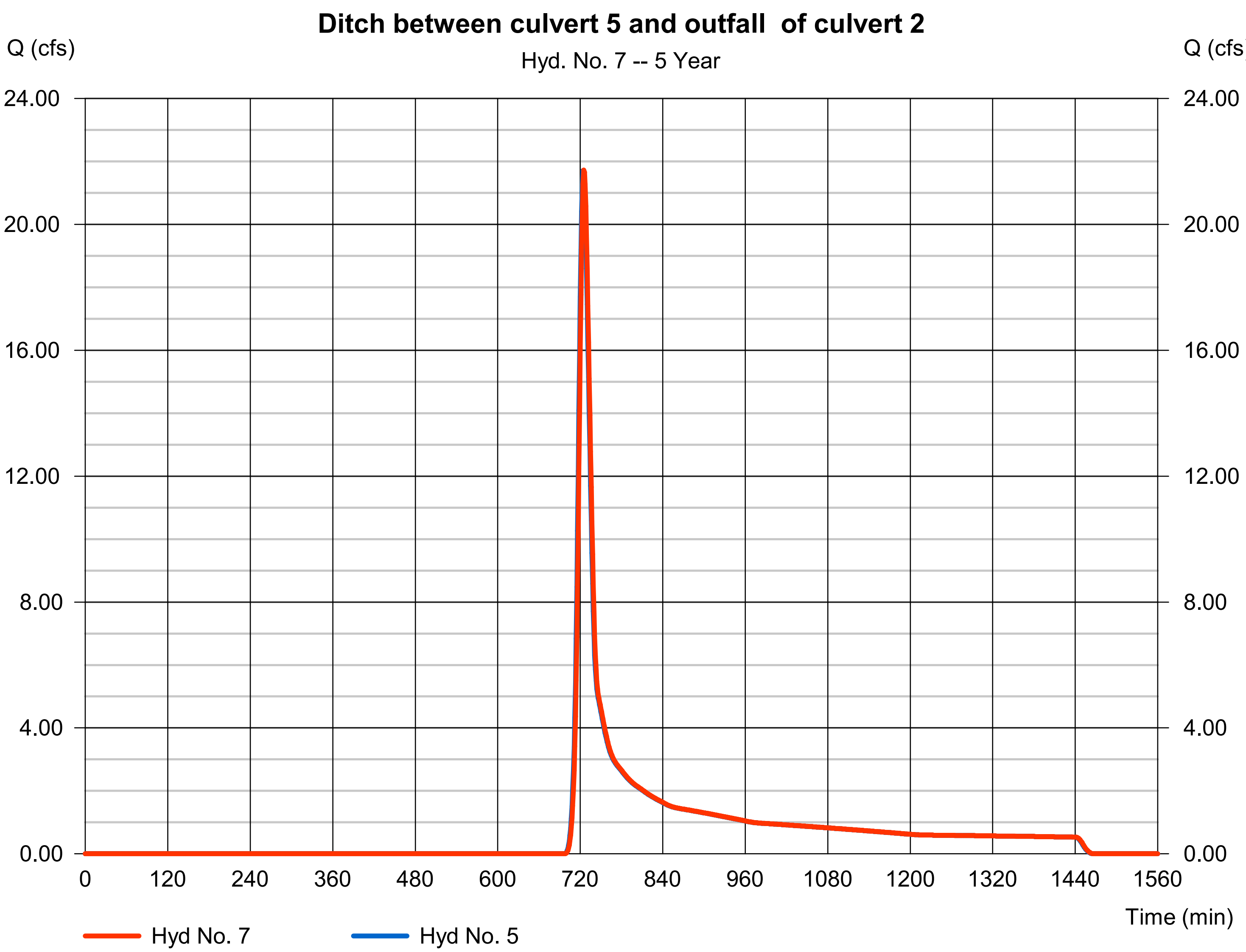
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 21.72 cfs
Storm frequency	= 5 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 71,413 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.0398

Modified Att-Kin routing method used.



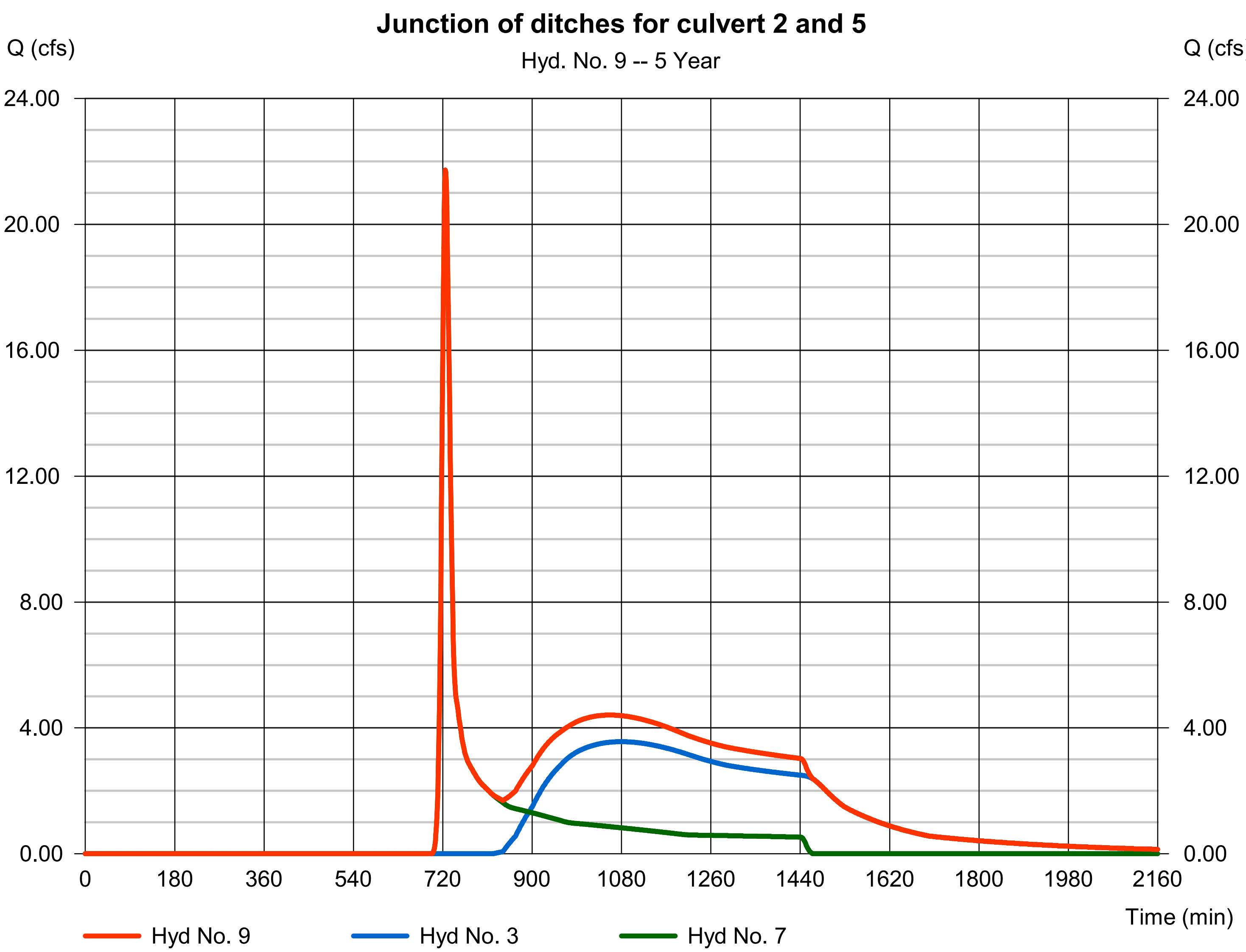
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 21.72 cfs
Storm frequency	= 5 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 203,647 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

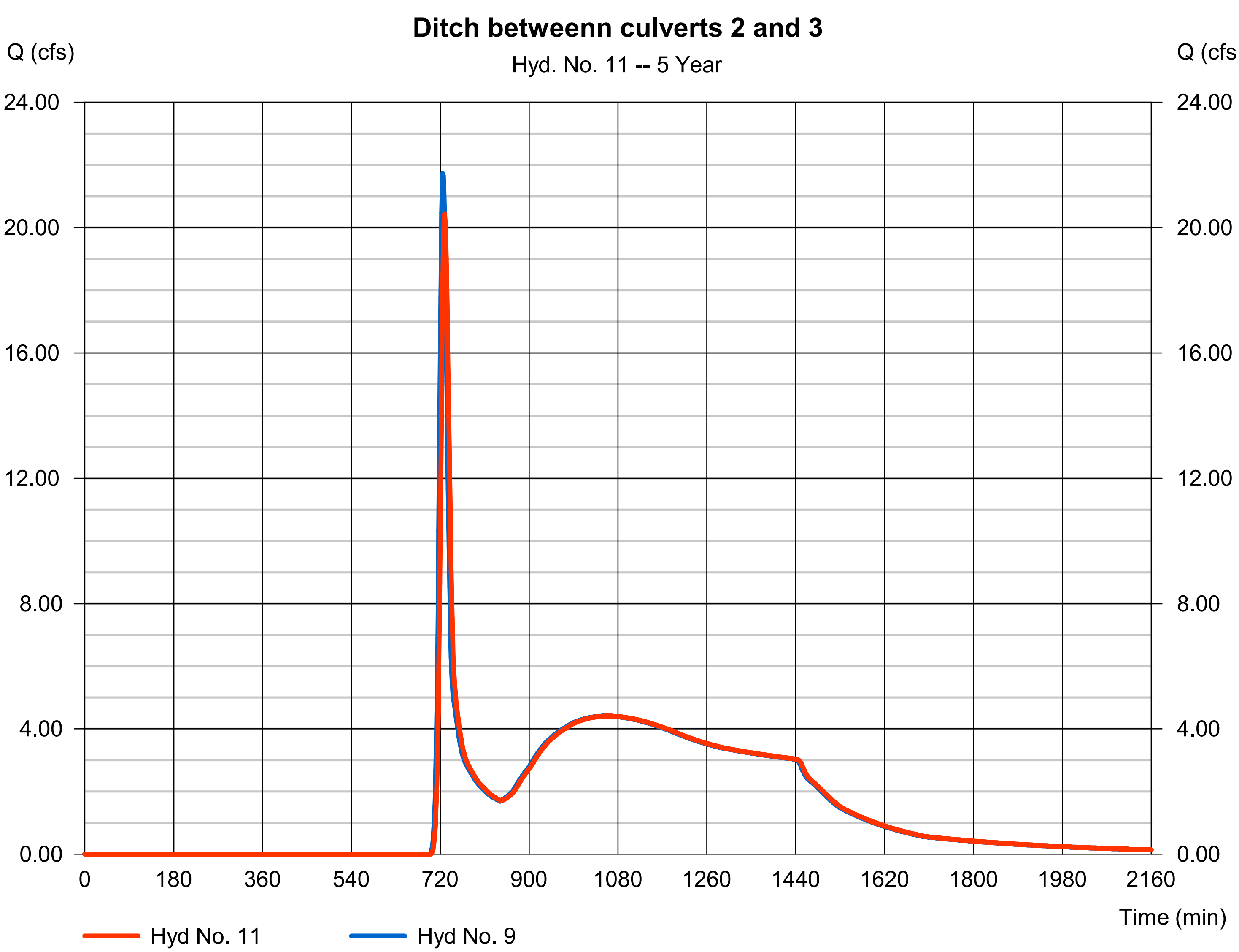
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 20.44 cfs
Storm frequency	= 5 yrs	Time to peak	= 729 min
Time interval	= 1 min	Hyd. volume	= 203,636 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culvert 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.2999

Modified Att-Kin routing method used.



Hydrograph Report

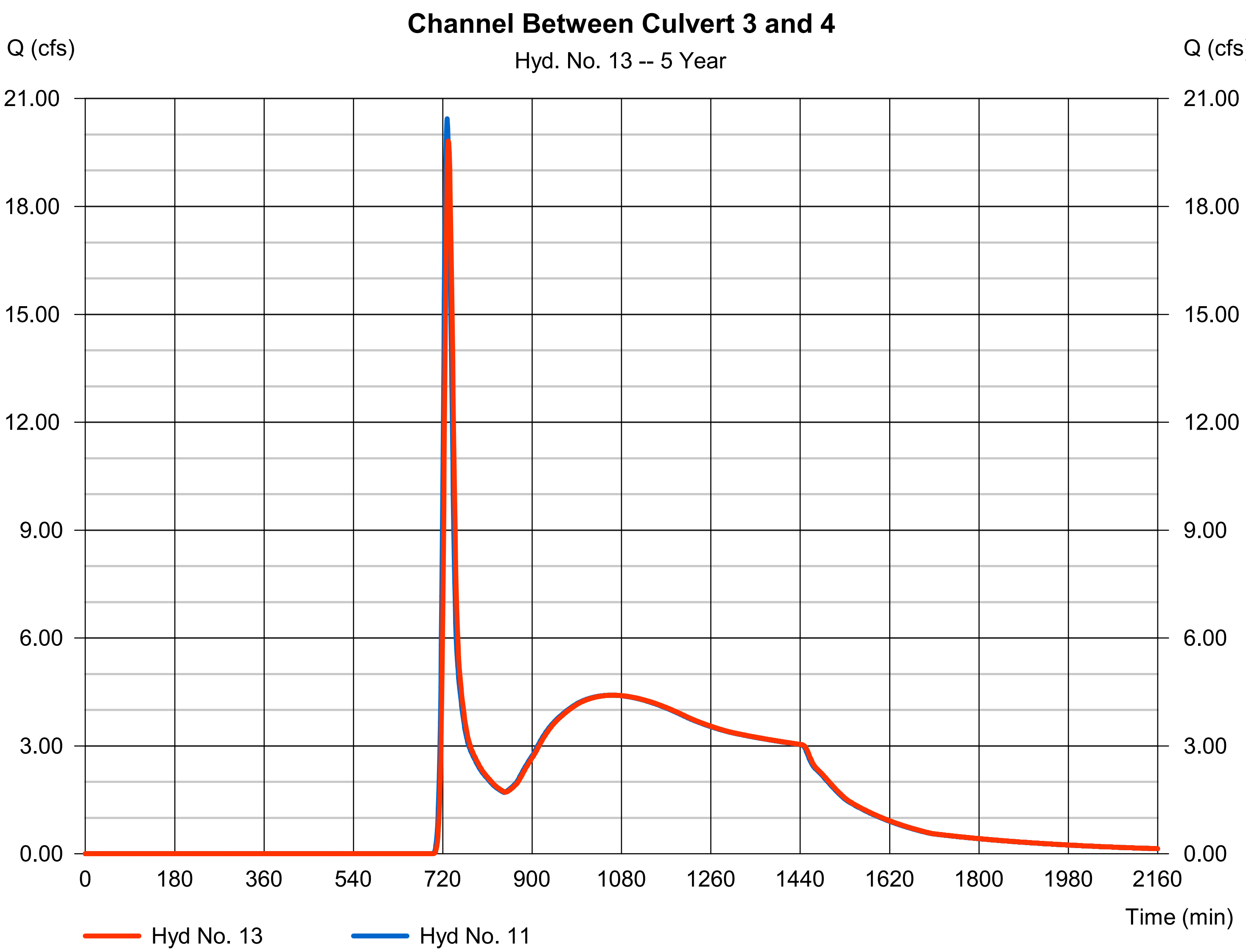
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 19.82 cfs
Storm frequency	= 5 yrs	Time to peak	= 731 min
Time interval	= 1 min	Hyd. volume	= 203,628 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.3816

Modified Att-Kin routing method used.



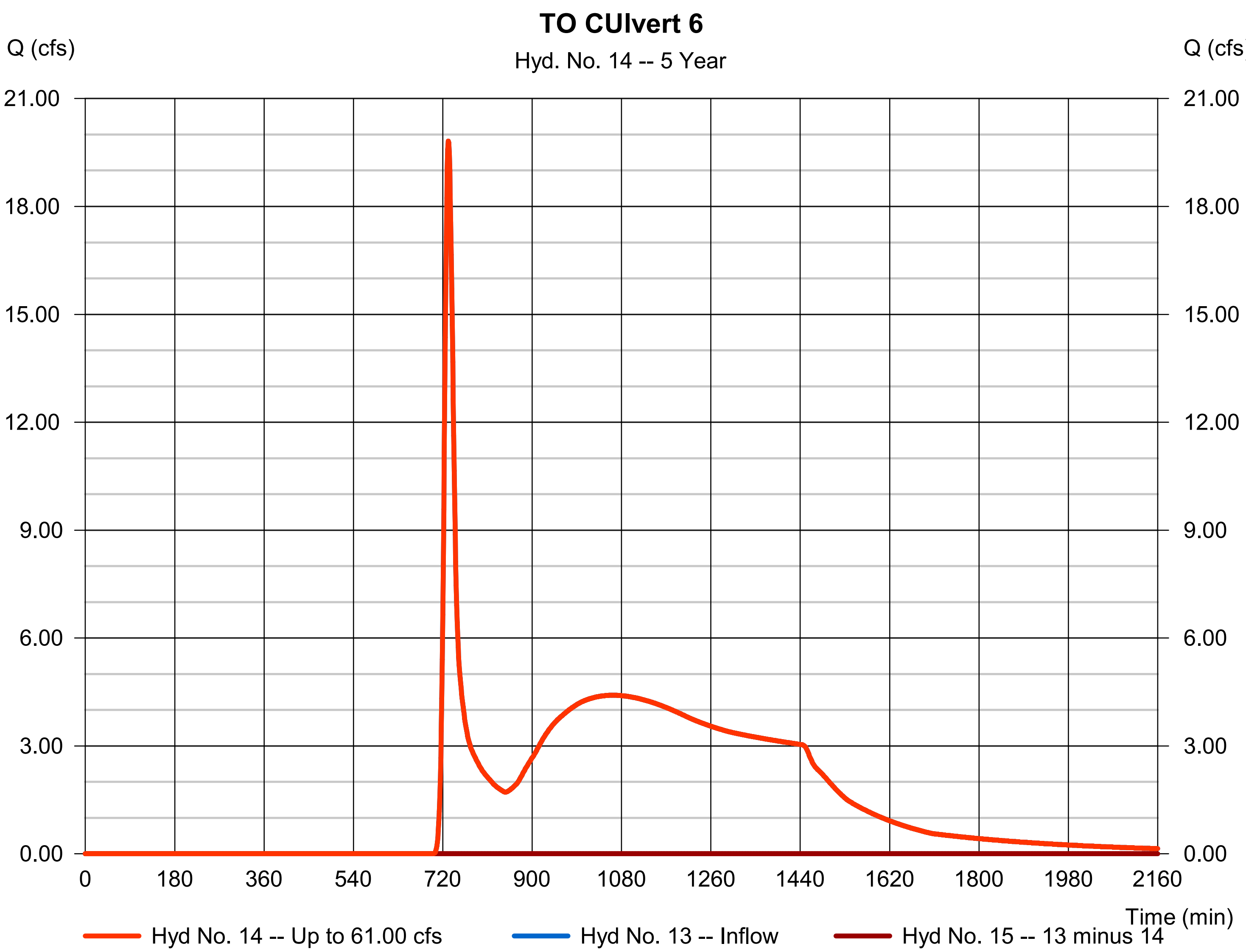
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 14

TO CUlvert 6

Hydrograph type	= Diversion1	Peak discharge	= 19.82 cfs
Storm frequency	= 5 yrs	Time to peak	= 731 min
Time interval	= 1 min	Hyd. volume	= 203,628 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 15
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



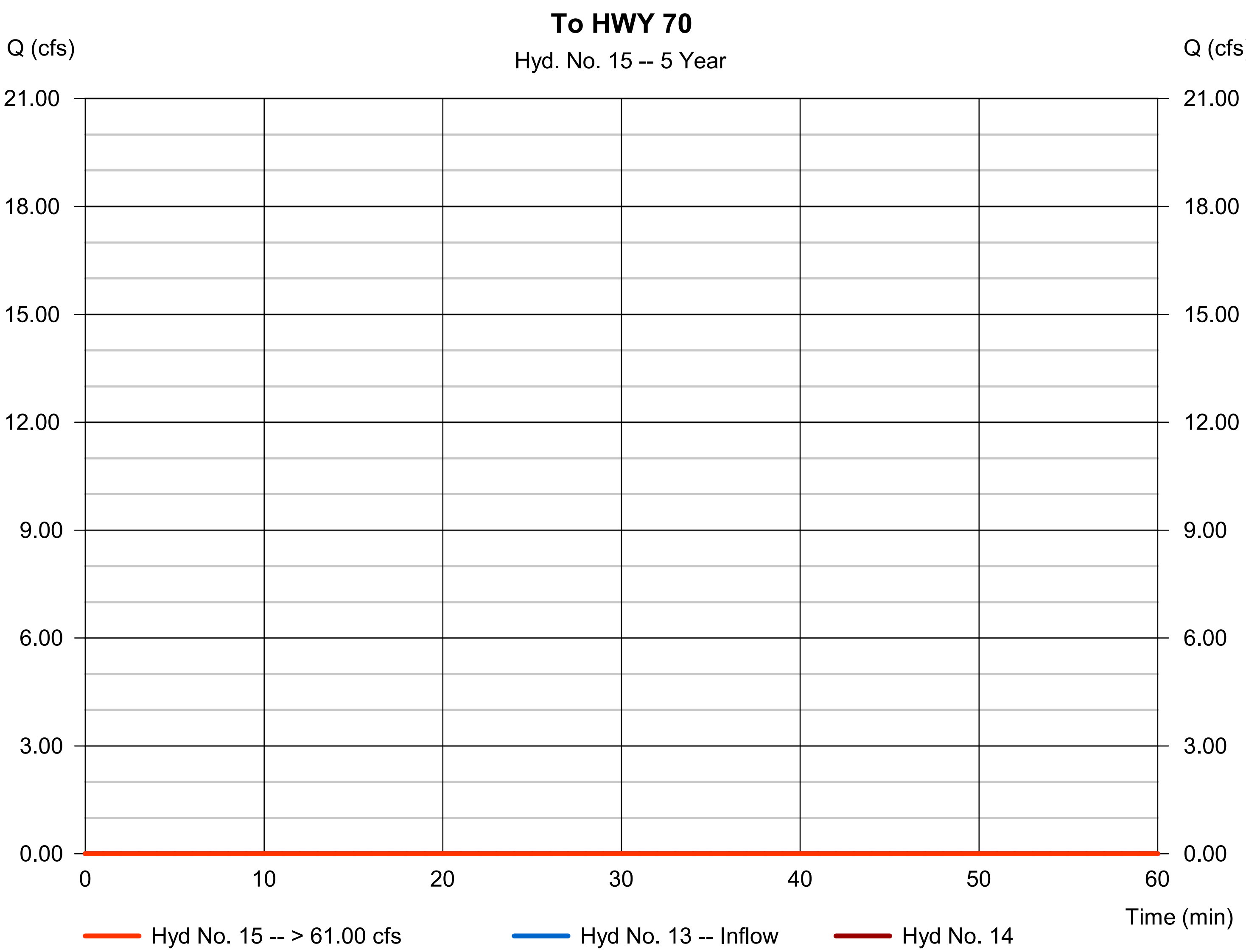
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 15

To HWY 70

Hydrograph type	= Diversion2	Peak discharge	= 0.000 cfs
Storm frequency	= 5 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 14
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



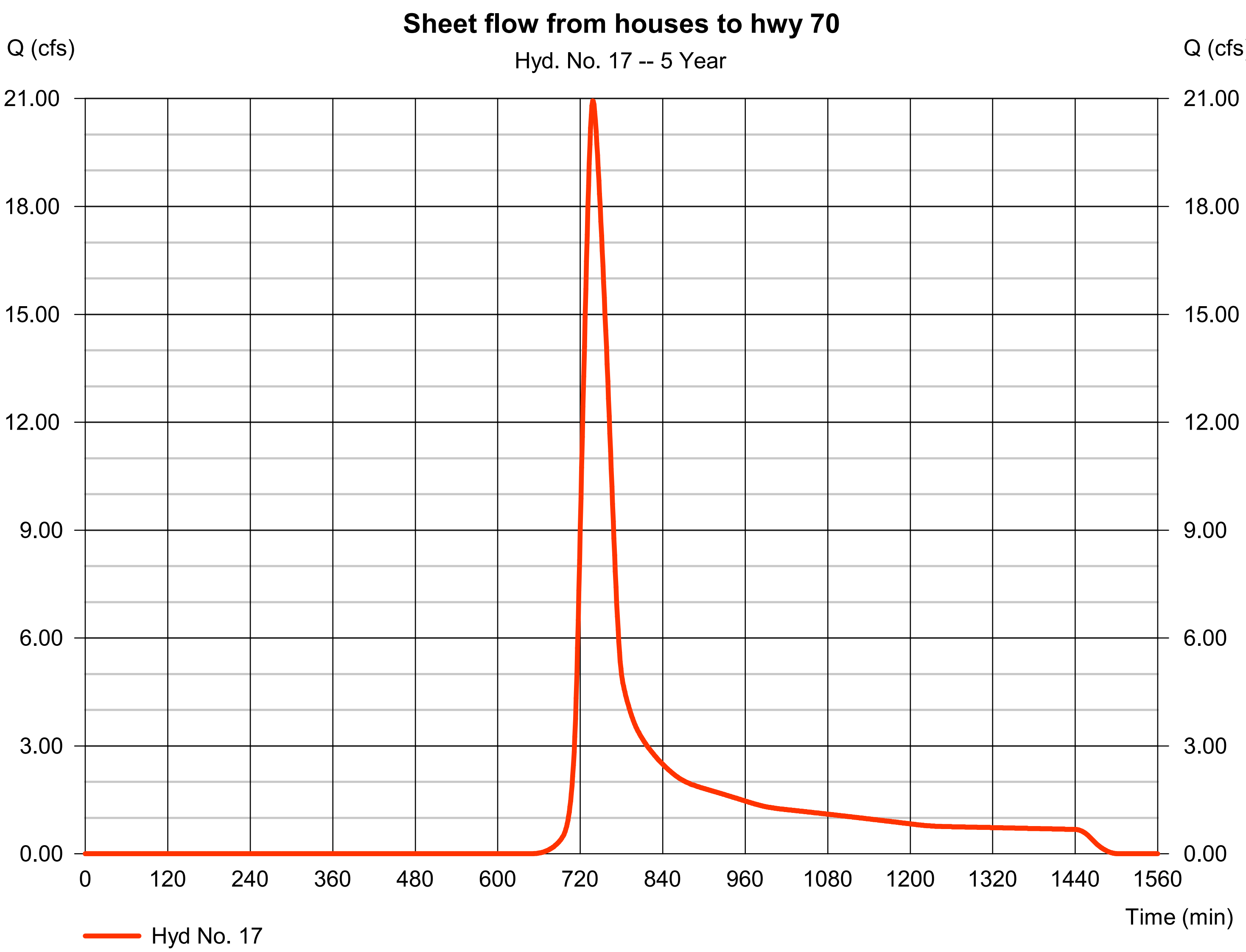
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 17

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 20.93 cfs
Storm frequency	= 5 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 108,627 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.63 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



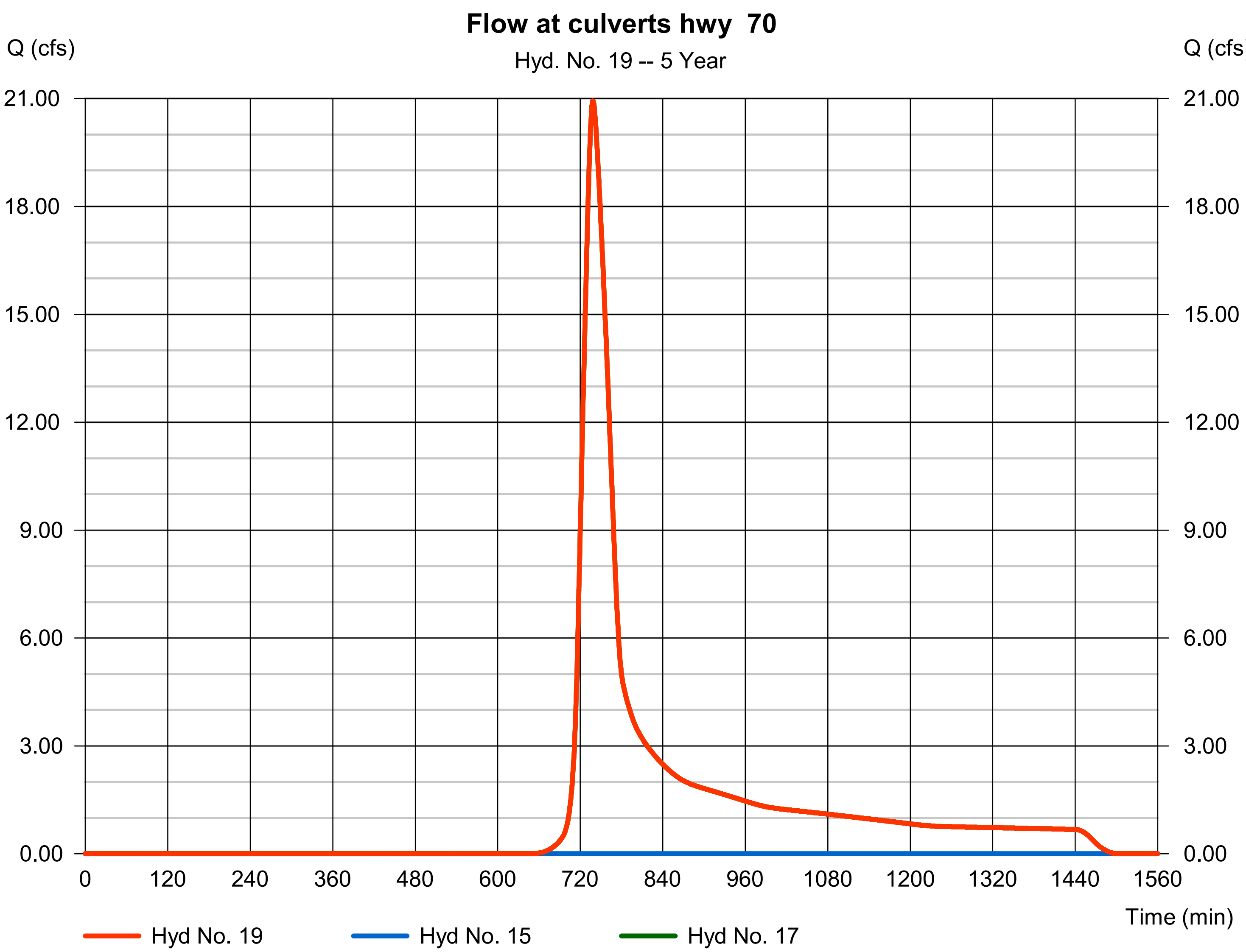
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 | Tuesday, 03 / 28 / 2017

Hyd. No. 19

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 20.93 cfs
Storm frequency	= 5 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 108,627 cuft
Inflow hyds.	= 15, 17	Contrib. drain. area	= 20.330 ac



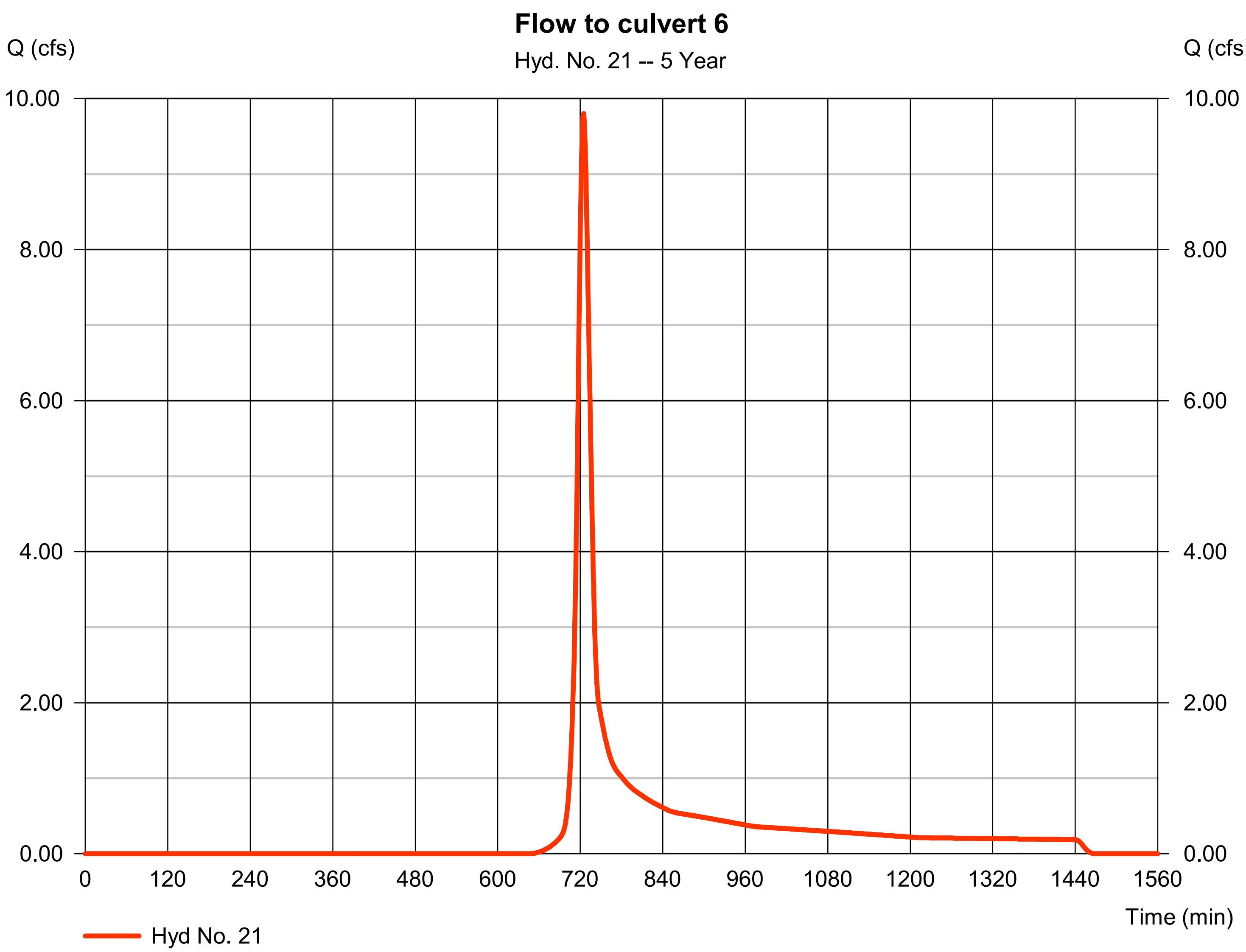
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 21

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 9.799 cfs
Storm frequency	= 5 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 30,216 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 4.41 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



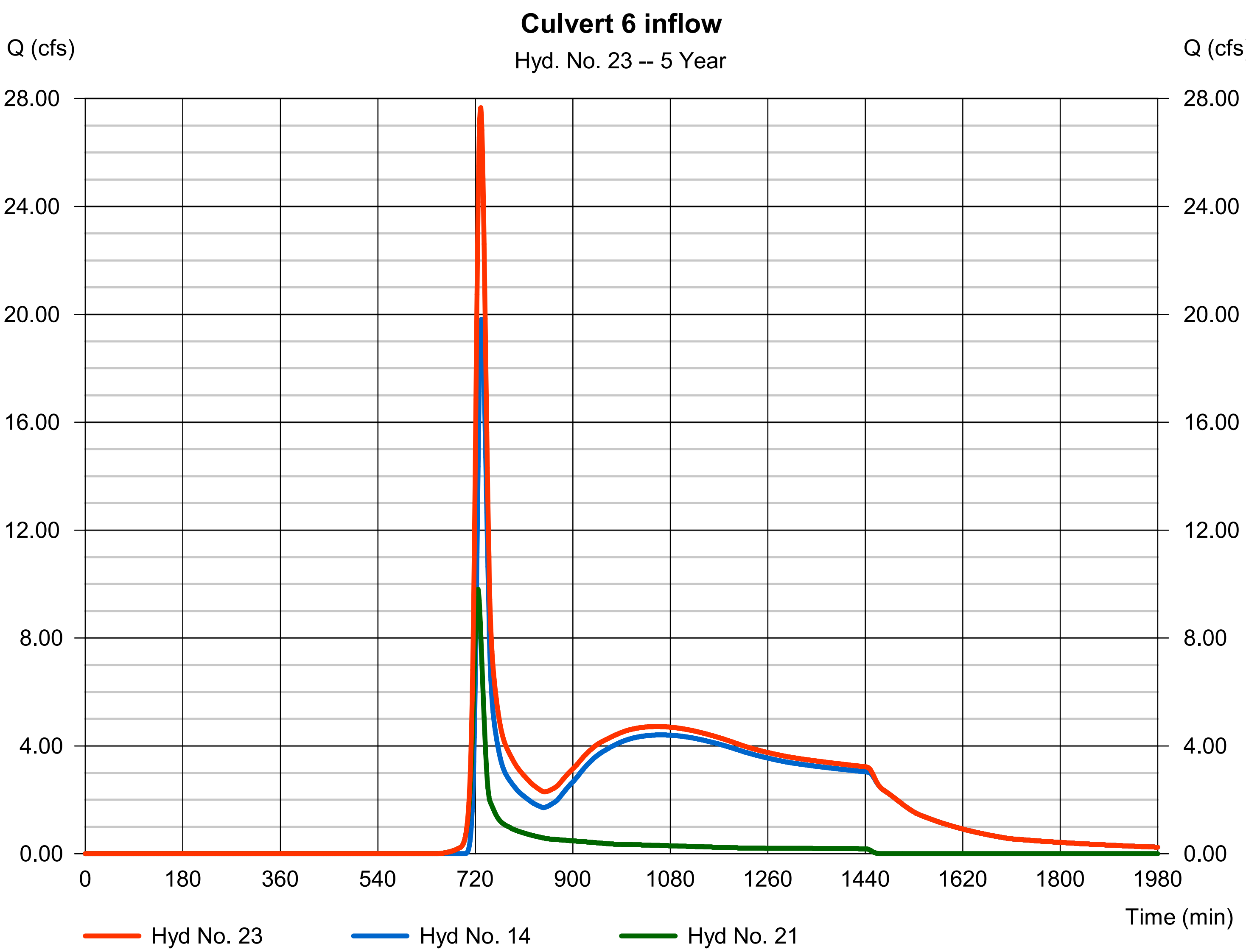
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 23

Culvert 6 inflow

Hydrograph type	= Combine	Peak discharge	= 27.66 cfs
Storm frequency	= 5 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 233,843 cuft
Inflow hyds.	= 14, 21	Contrib. drain. area	= 5.720 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	69.68	1	737	385,603	------	------	------	Area Above Hannah Ford leading to
2	Reservoir	7.365	1	902	244,287	1	39.32	200,110	Pond
3	Reach	7.365	1	903	244,284	2	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	31.32	1	724	97,360	------	------	------	Area above culvert 5 to culvert 5
7	Reach	31.35	1	725	97,359	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	31.35	1	725	341,643	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	29.78	1	728	341,633	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	28.99	1	730	341,626	11	------	------	Channel Between Culvert 3 and 4
14	Diversion1	28.99	1	730	341,626	13	------	------	TO CUlvert 6
15	Diversion2	0.000	1	n/a	0	13	------	------	To HWY 70
17	SCS Runoff	27.87	1	738	140,815	------	------	------	Sheet flow from houses to hwy 70
19	Combine	27.87	1	738	140,815	15, 17,	------	------	Flow at culverts hwy 70
21	SCS Runoff	12.92	1	725	39,169	------	------	------	Flow to culvert 6
23	Combine	39.78	1	729	380,795	14, 21,	------	------	Culvert 6 inflow

Diversion analysis with 1 pond (1).gpw	Return Period: 10 Year	Tuesday, 03 / 28 / 2017

Hydrograph Report

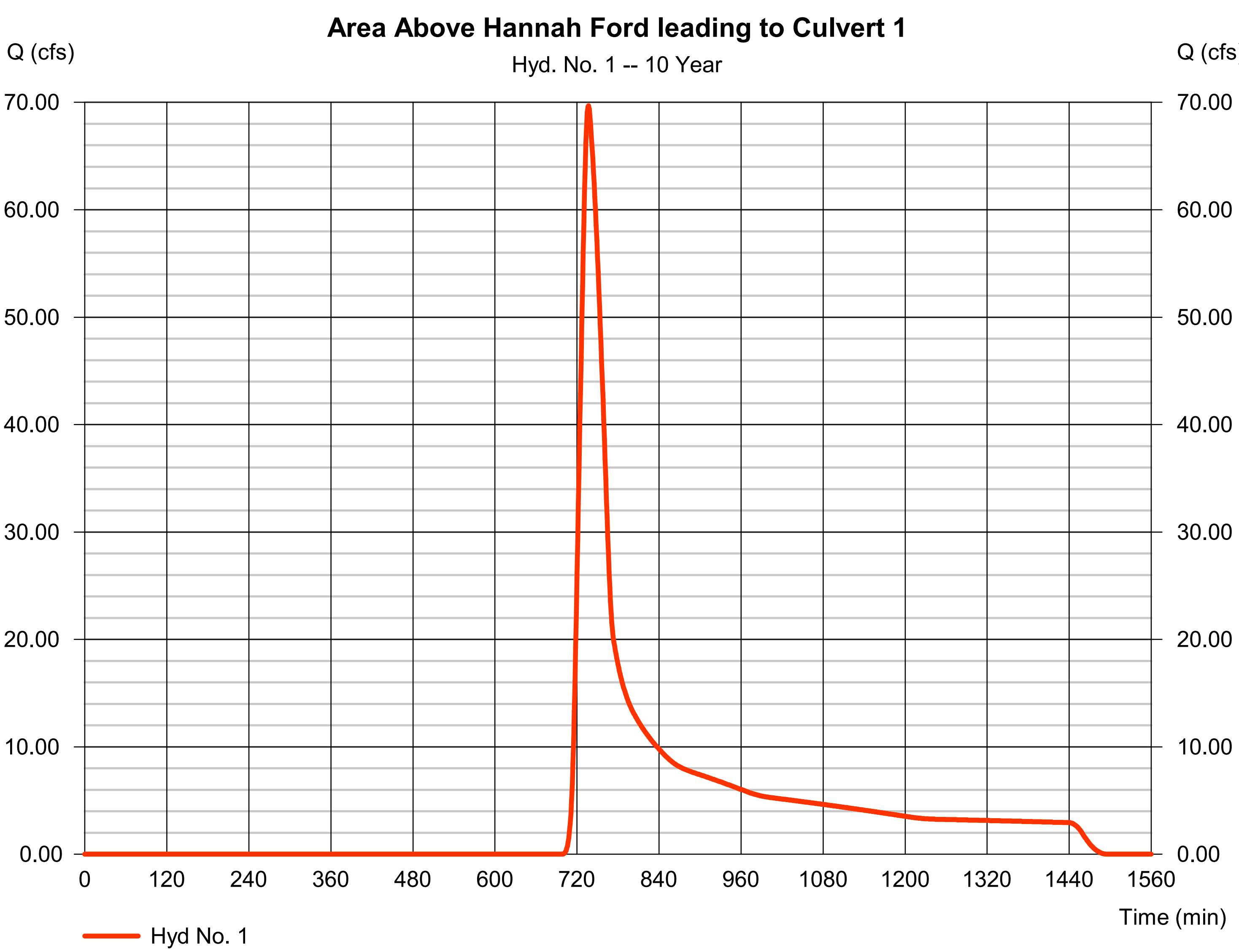
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 69.68 cfs
Storm frequency	= 10 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 385,603 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

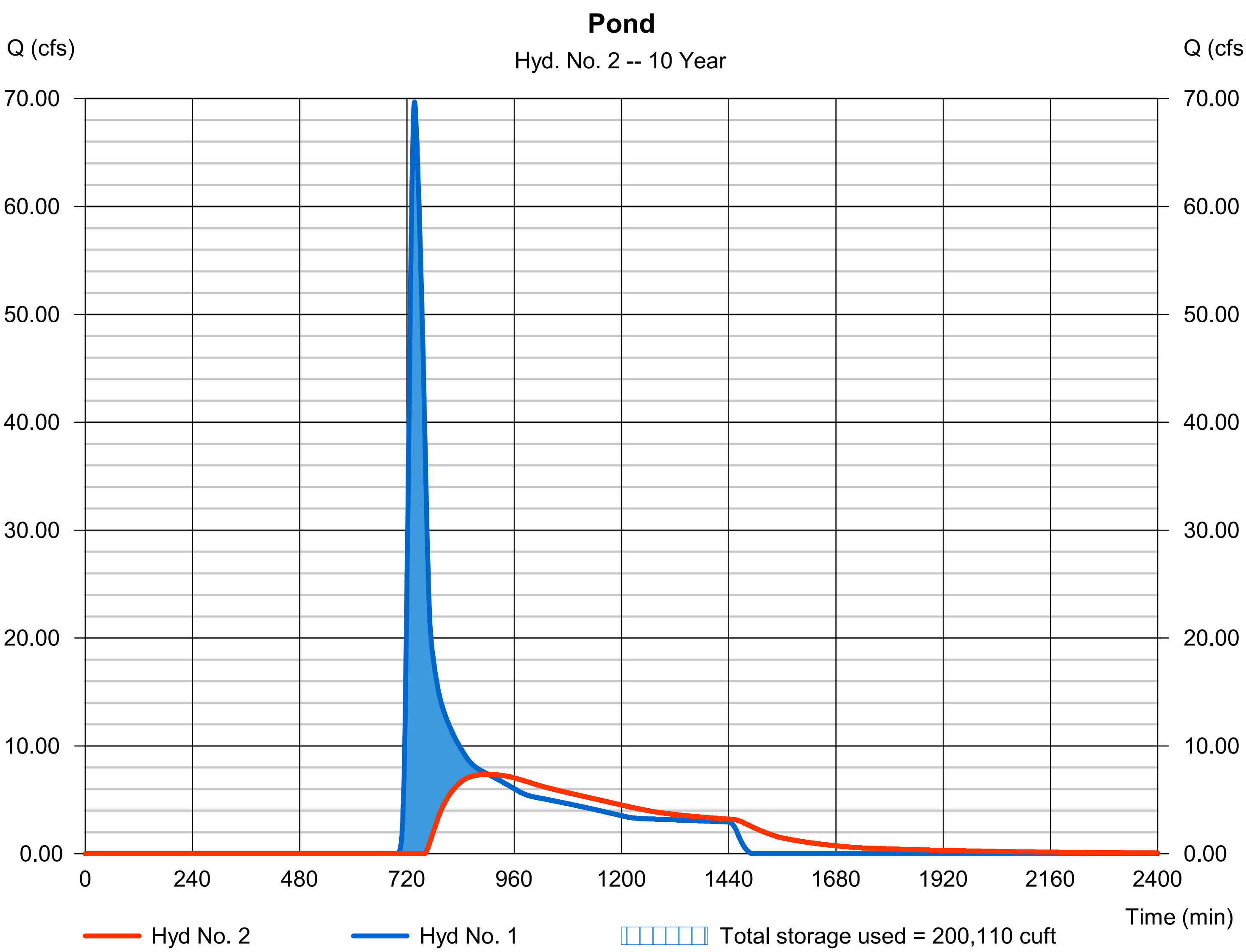
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 2

Pond

Hydrograph type	= Reservoir	Peak discharge	= 7.365 cfs
Storm frequency	= 10 yrs	Time to peak	= 902 min
Time interval	= 1 min	Hyd. volume	= 244,287 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Max. Elevation	= 39.32 ft
Reservoir name	= Pond Paired with Diversion	Max. Storage	= 200,110 cuft

Storage Indication method used.



Hydrograph Report

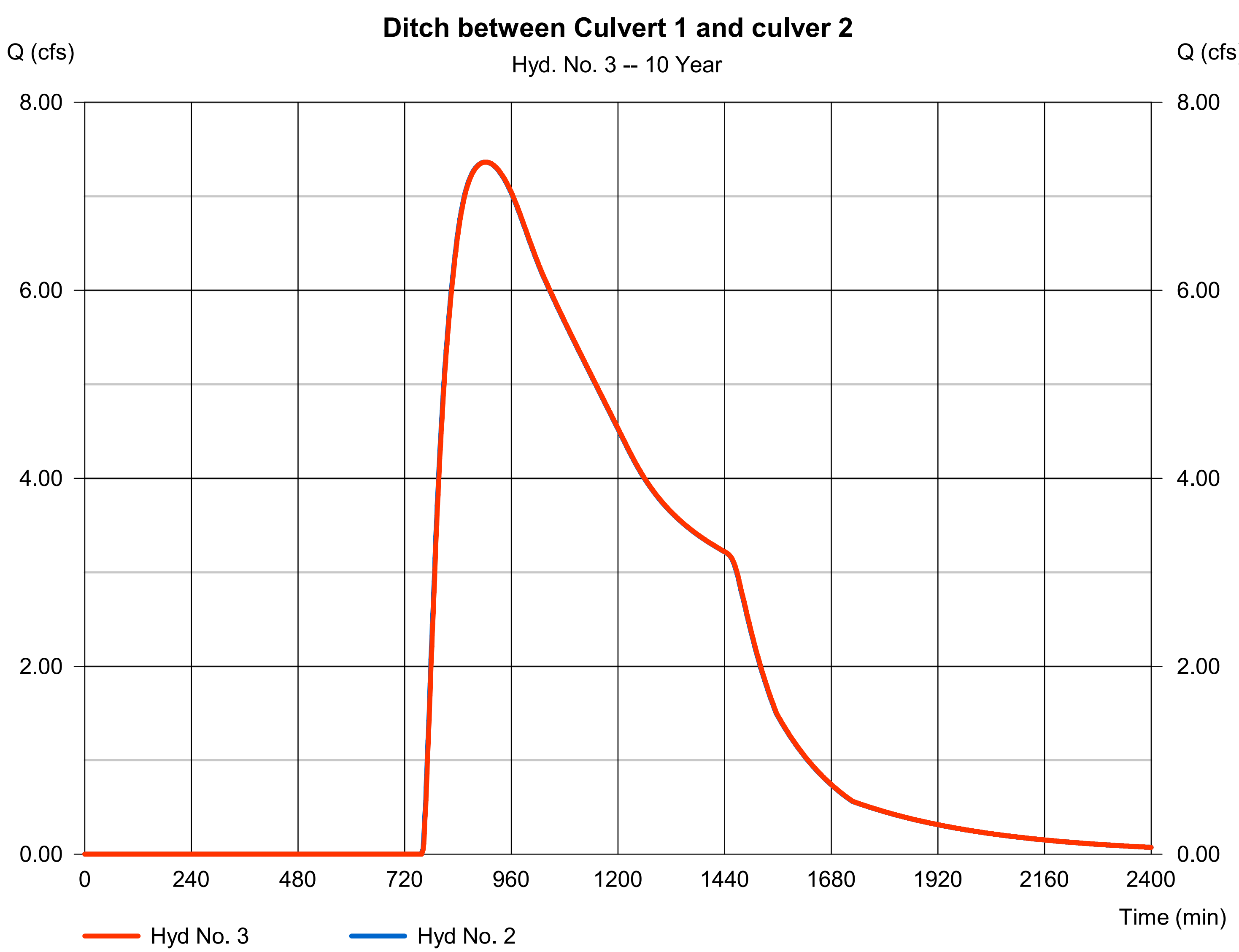
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 7.365 cfs
Storm frequency	= 10 yrs	Time to peak	= 903 min
Time interval	= 1 min	Hyd. volume	= 244,284 cuft
Inflow hyd. No.	= 2 - Pond	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.1106

Modified Att-Kin routing method used.



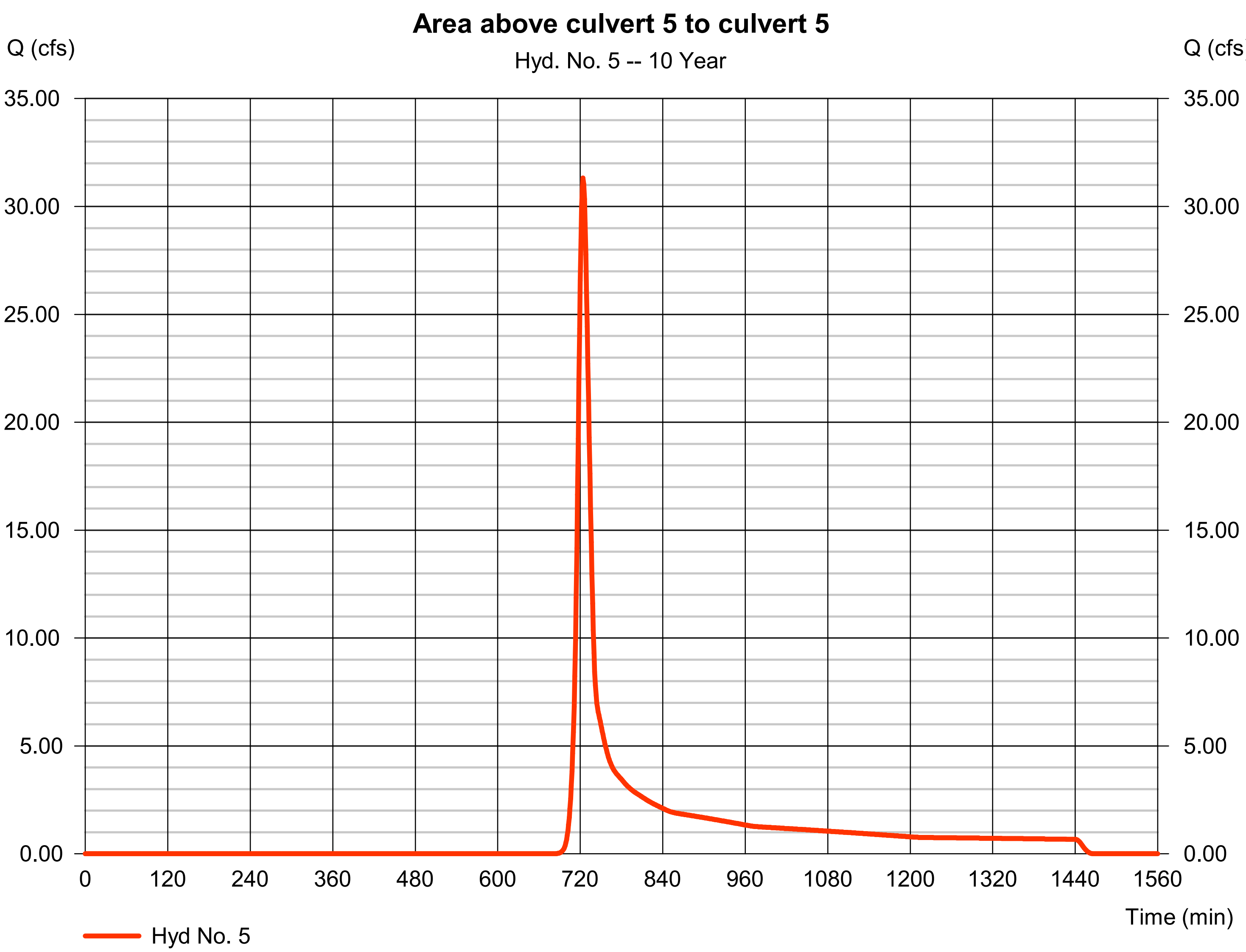
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 31.32 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 97,360 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

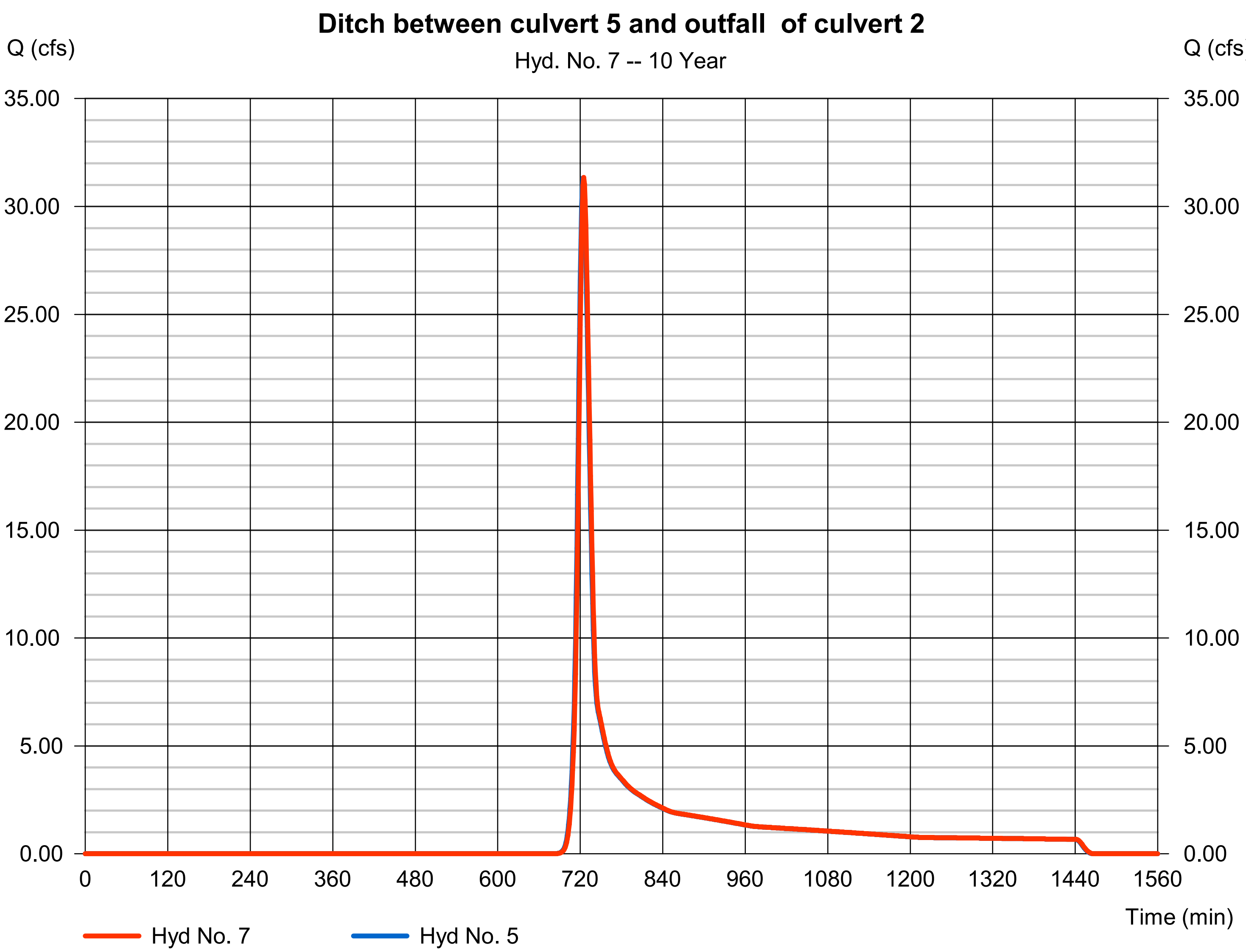
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 31.35 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 97,359 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.0762

Modified Att-Kin routing method used.



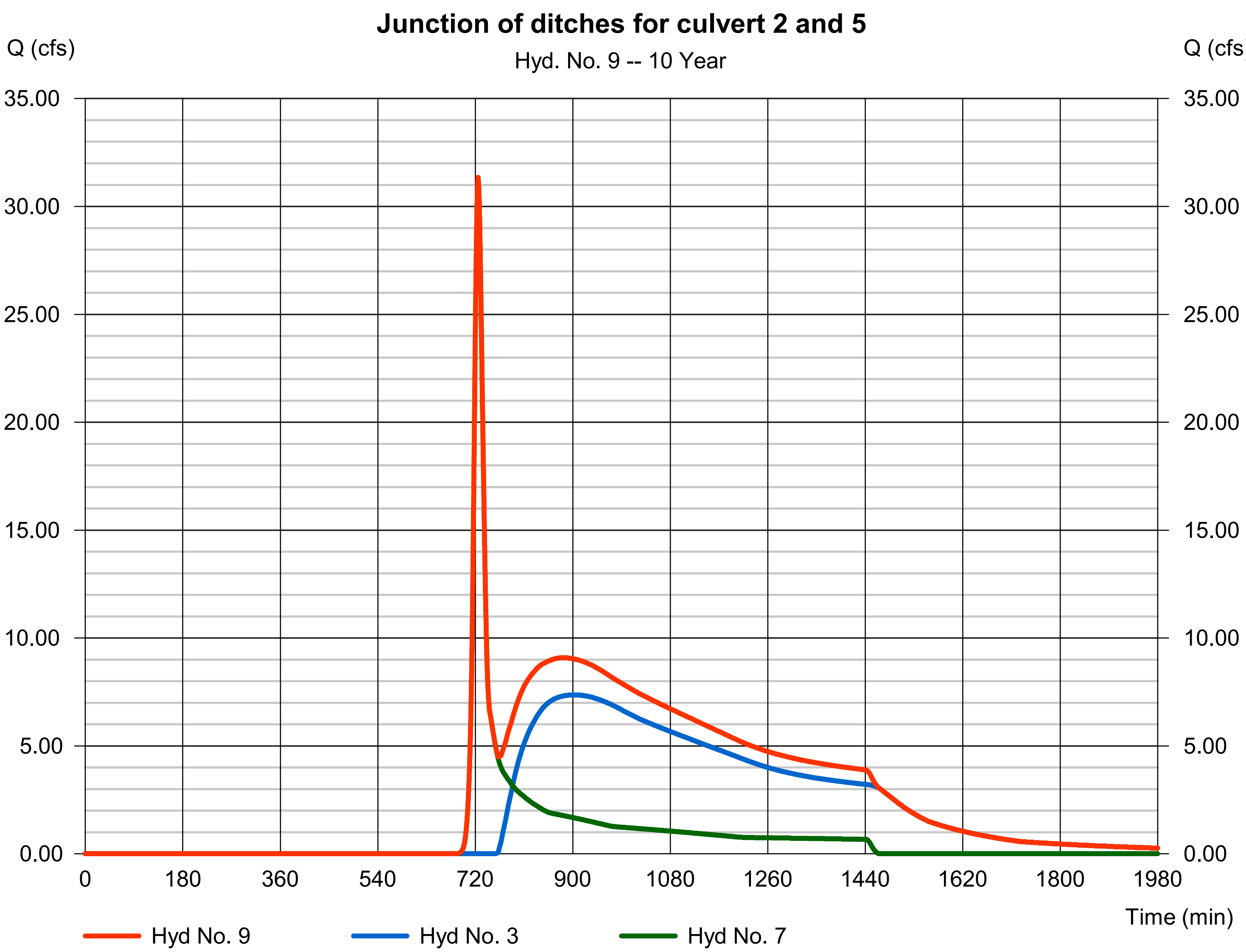
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 31.35 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 341,643 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

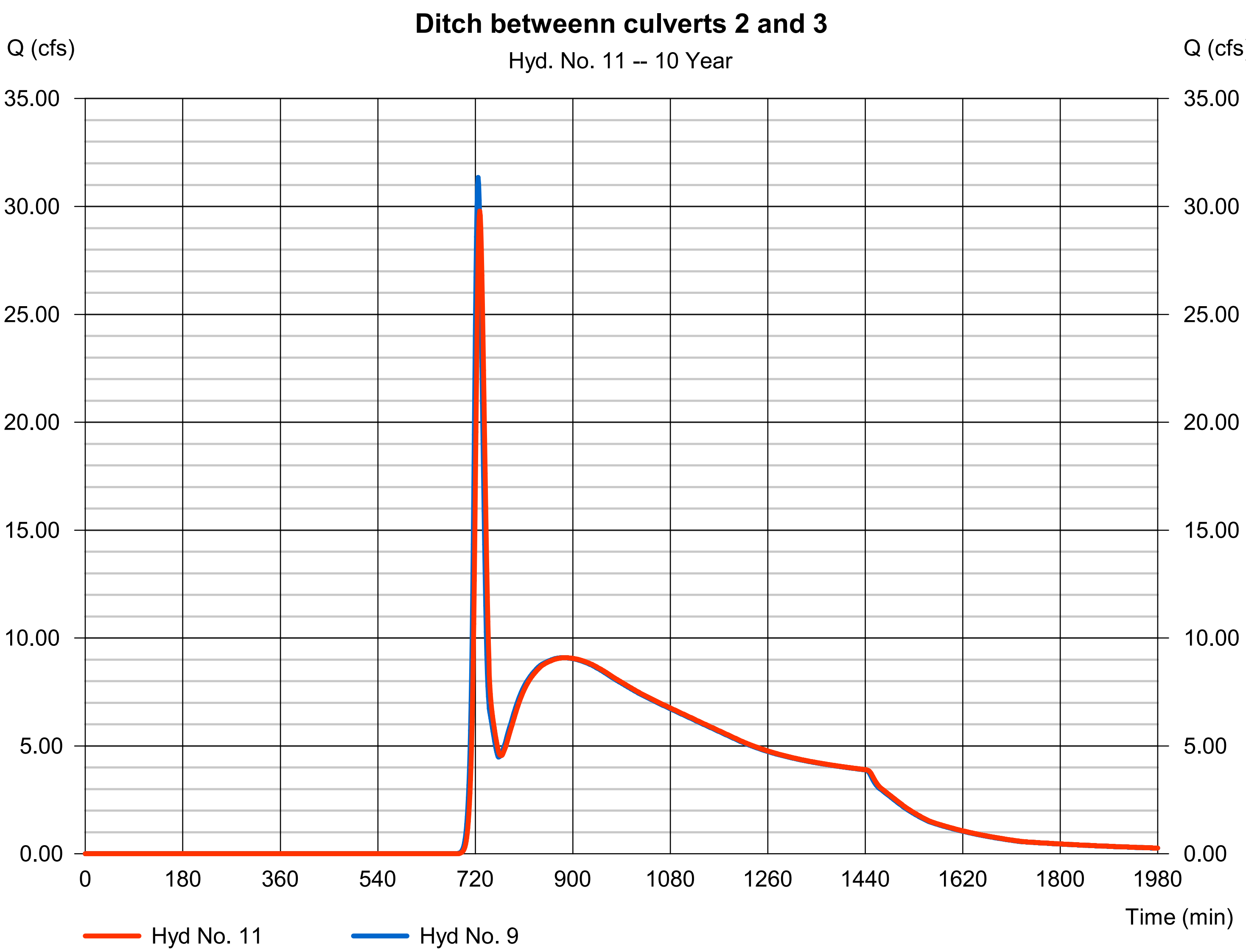
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	=	Reach	Peak discharge	=	29.78 cfs
Storm frequency	=	10 yrs	Time to peak	=	728 min
Time interval	=	1 min	Hyd. volume	=	341,633 cuft
Inflow hyd. No.	=	9 - Junction of ditches for culvert 2 and 5	Section type	=	Trapezoidal
Reach length	=	815.0 ft	Channel slope	=	2.3 %
Manning's n	=	0.040	Bottom width	=	5.0 ft
Side slope	=	3.0:1	Max. depth	=	5.0 ft
Rating curve x	=	1.931	Rating curve m	=	1.341
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.3245

Modified Att-Kin routing method used.



Hydrograph Report

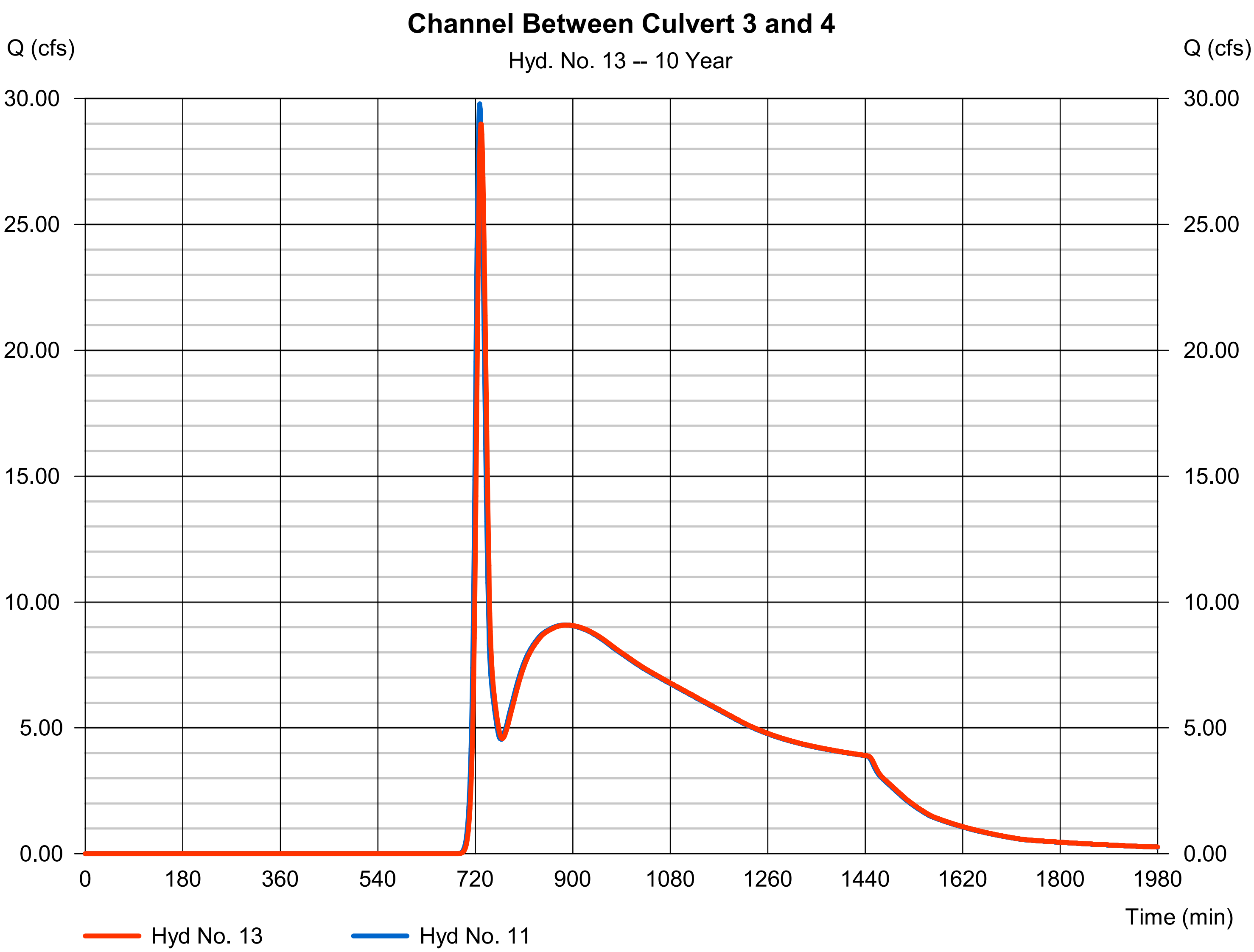
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 28.99 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 341,626 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.4106

Modified Att-Kin routing method used.



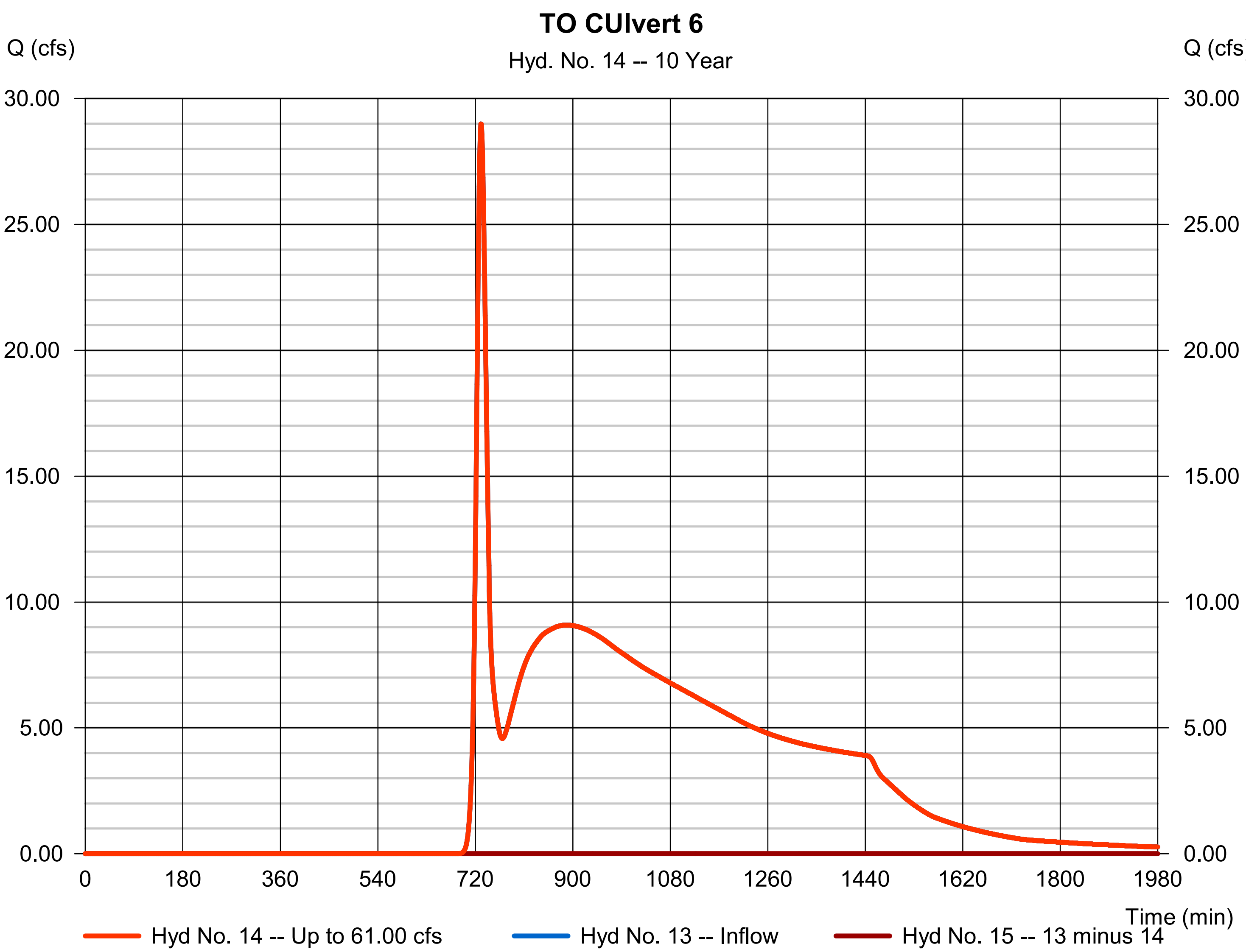
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 14

TO CUlvert 6

Hydrograph type	= Diversion1	Peak discharge	= 28.99 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 341,626 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 15
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



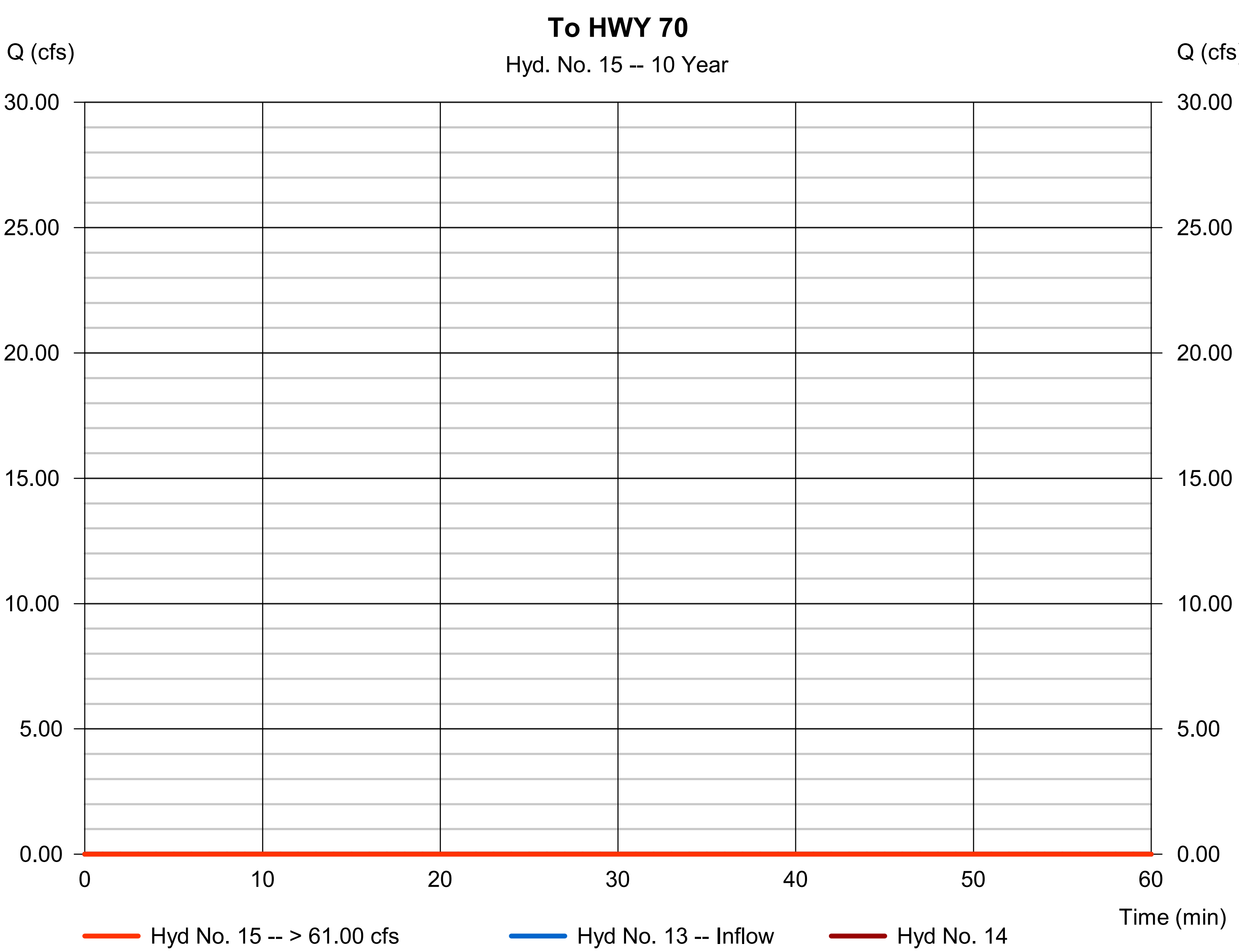
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 15

To HWY 70

Hydrograph type	= Diversion2	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 14
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



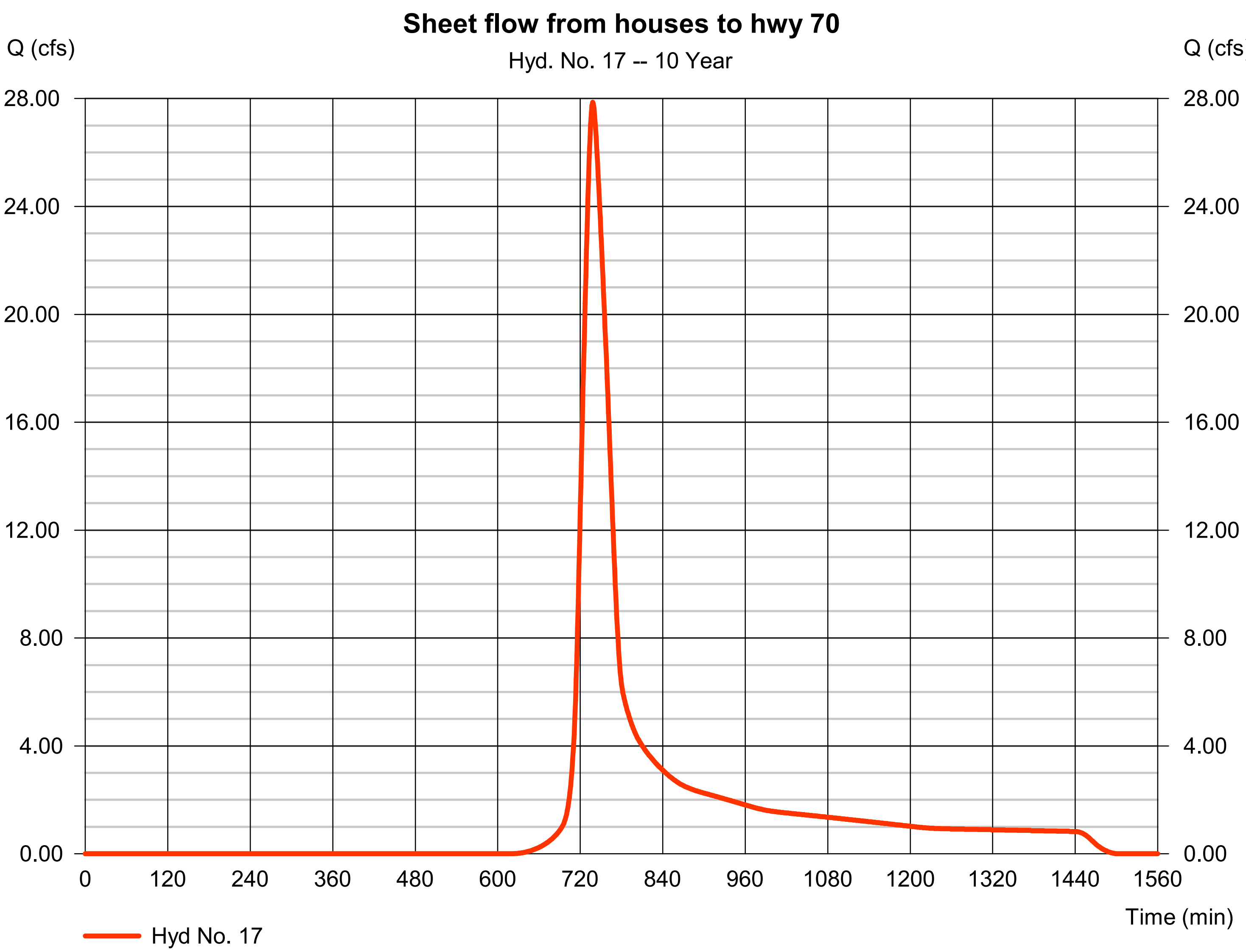
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 17

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 27.87 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 140,815 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.63 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



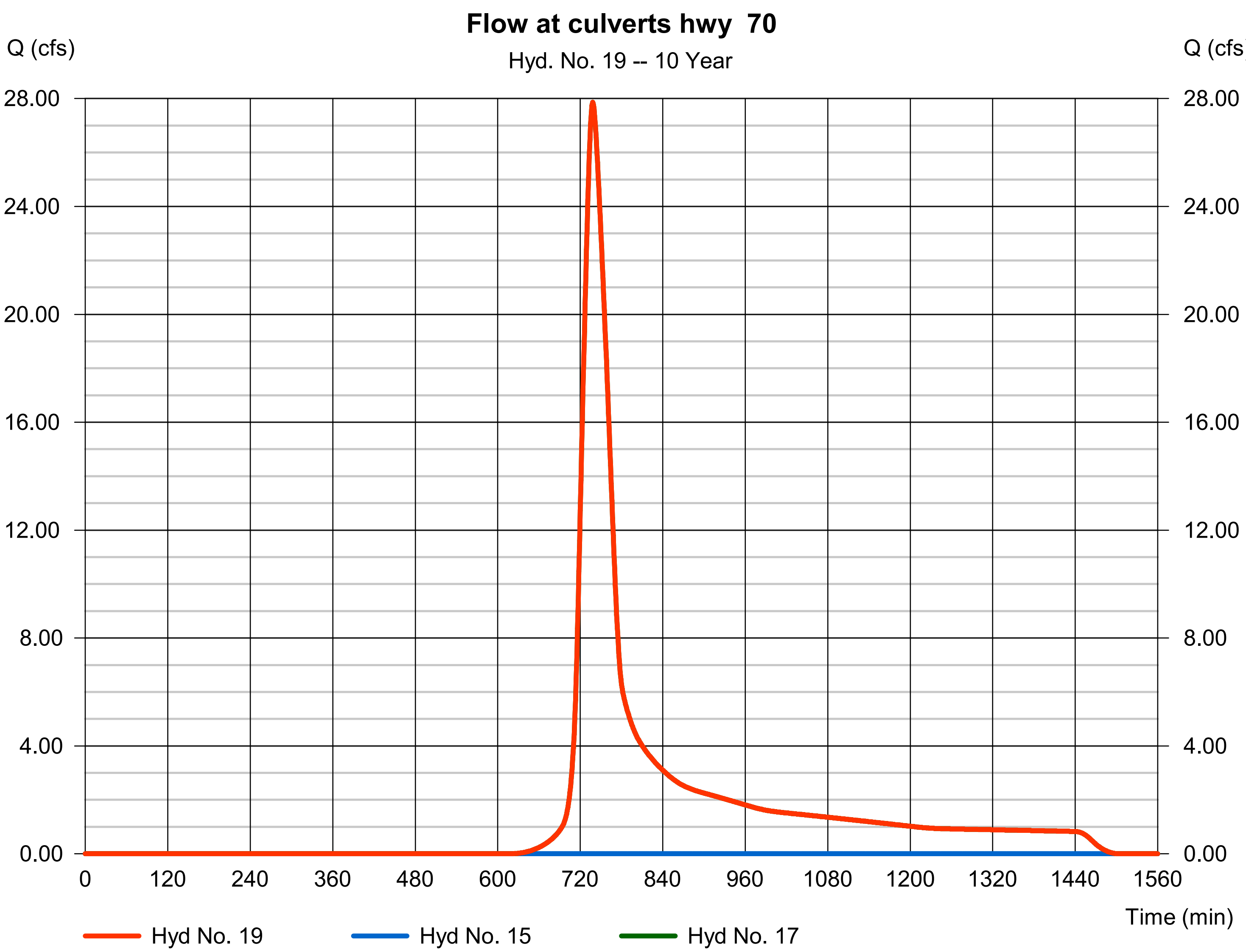
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 19

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 27.87 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 140,815 cuft
Inflow hyds.	= 15, 17	Contrib. drain. area	= 20.330 ac



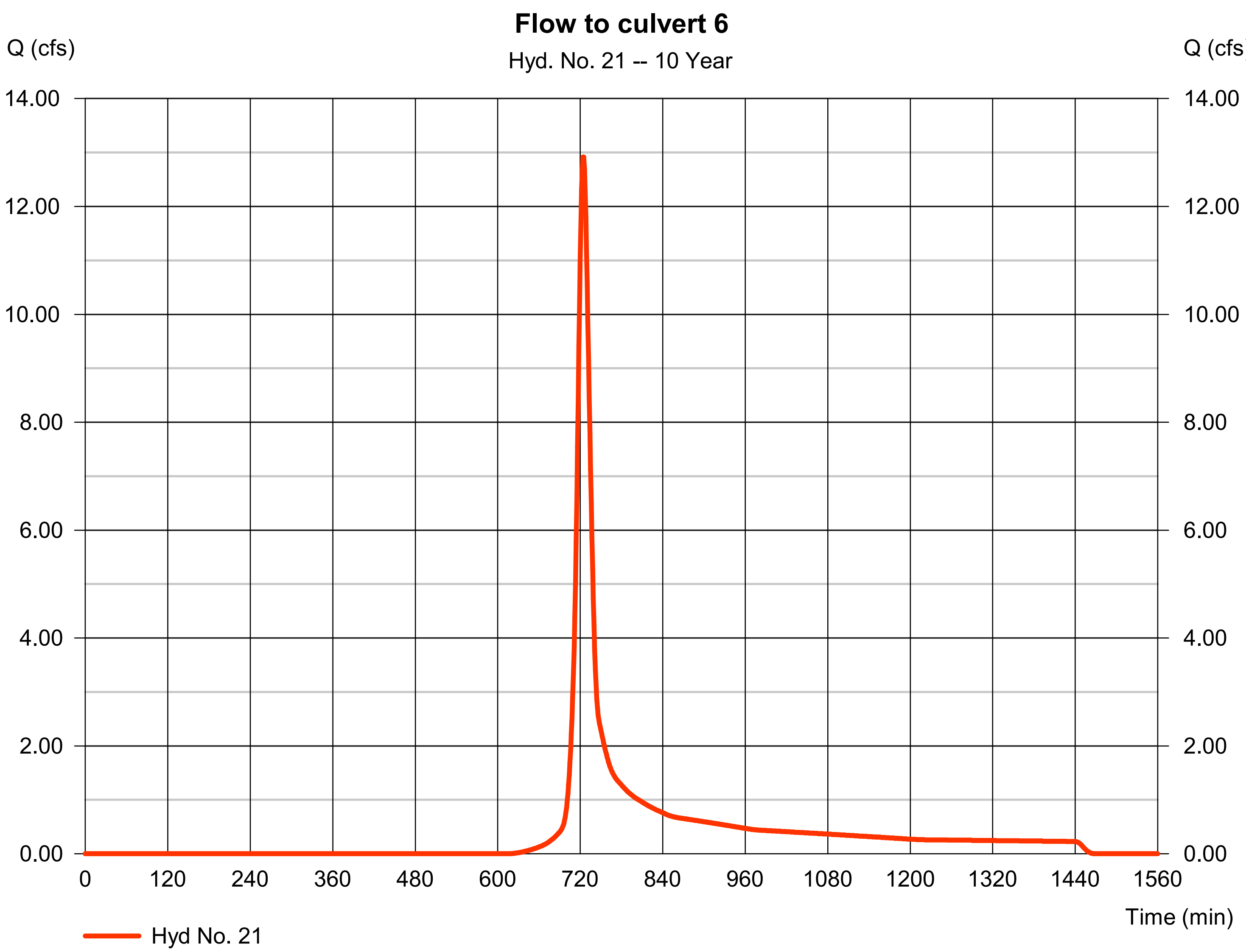
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 21

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 12.92 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 39,169 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 5.04 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



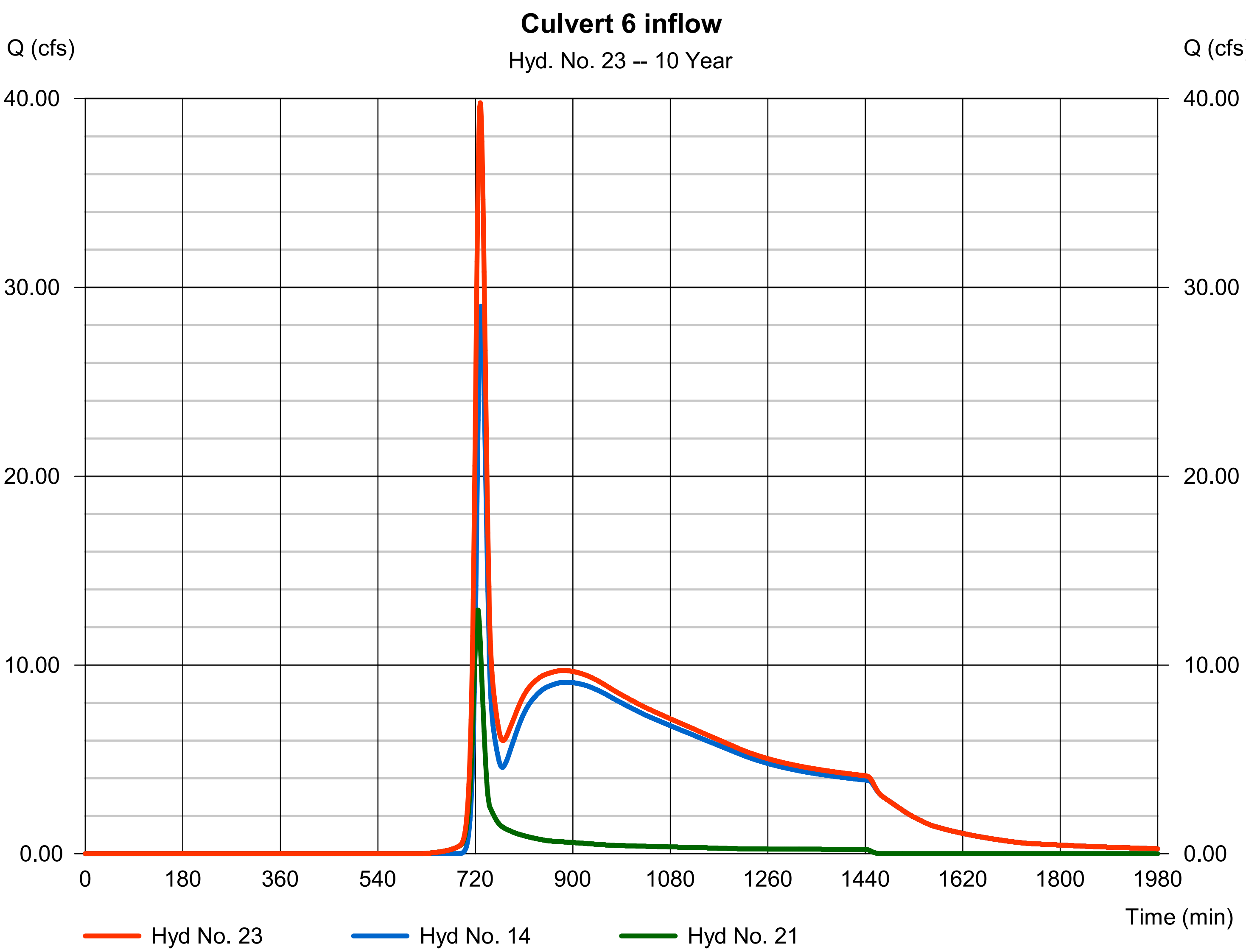
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 23

Culvert 6 inflow

Hydrograph type	= Combine	Peak discharge	= 39.78 cfs
Storm frequency	= 10 yrs	Time to peak	= 729 min
Time interval	= 1 min	Hyd. volume	= 380,795 cuft
Inflow hyds.	= 14, 21	Contrib. drain. area	= 5.720 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	112.65	1	736	568,777	------	------	------	Area Above Hannah Ford leading to
2	Reservoir	16.34	1	816	427,361	1	40.32	257,068	Pond
3	Reach	16.34	1	817	427,358	2	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	46.54	1	724	138,852	------	------	------	Area above culvert 5 to culvert 5
7	Reach	46.56	1	725	138,852	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	46.56	1	725	566,209	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	44.65	1	727	566,200	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	43.75	1	730	566,192	11	------	------	Channel Between Culvert 3 and 4
14	Diversion1	43.75	1	730	566,192	13	------	------	TO CUlvert 6
15	Diversion2	0.000	1	n/a	0	13	------	------	To HWY 70
17	SCS Runoff	38.53	1	738	190,584	------	------	------	Sheet flow from houses to hwy 70
19	Combine	38.53	1	738	190,584	15, 17,	------	------	Flow at culverts hwy 70
21	SCS Runoff	17.74	1	724	53,013	------	------	------	Flow to culvert 6
23	Combine	58.95	1	728	619,204	14, 21,	------	------	Culvert 6 inflow

Diversion analysis with 1 pond (1).gpw	Return Period: 25 Year	Tuesday, 03 / 28 / 2017

Hydrograph Report

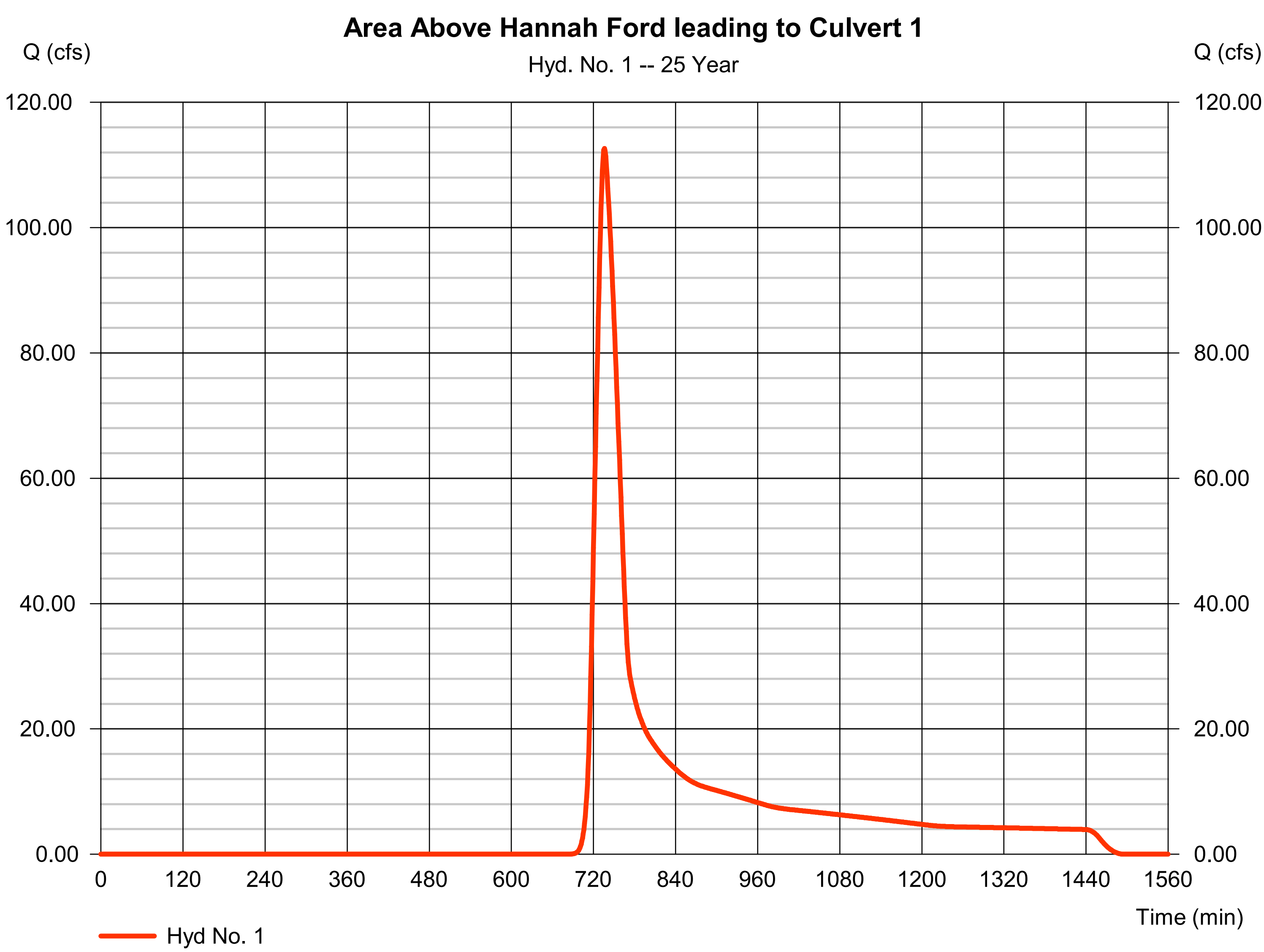
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 112.65 cfs
Storm frequency	= 25 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 568,777 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

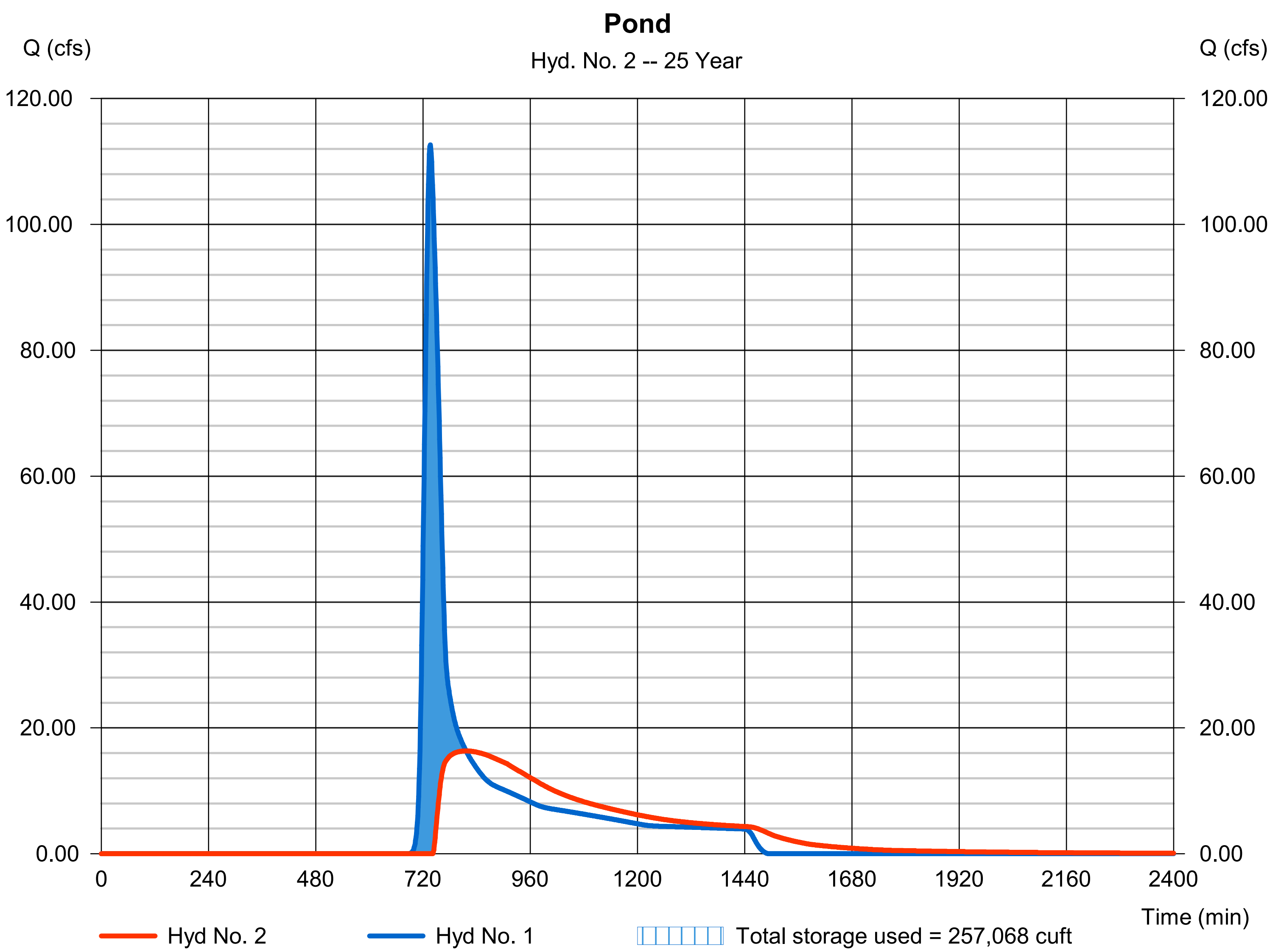
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 2

Pond

Hydrograph type	= Reservoir	Peak discharge	= 16.34 cfs
Storm frequency	= 25 yrs	Time to peak	= 816 min
Time interval	= 1 min	Hyd. volume	= 427,361 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Max. Elevation	= 40.32 ft
Reservoir name	= Pond Paired with Diversion	Max. Storage	= 257,068 cuft

Storage Indication method used.



Hydrograph Report

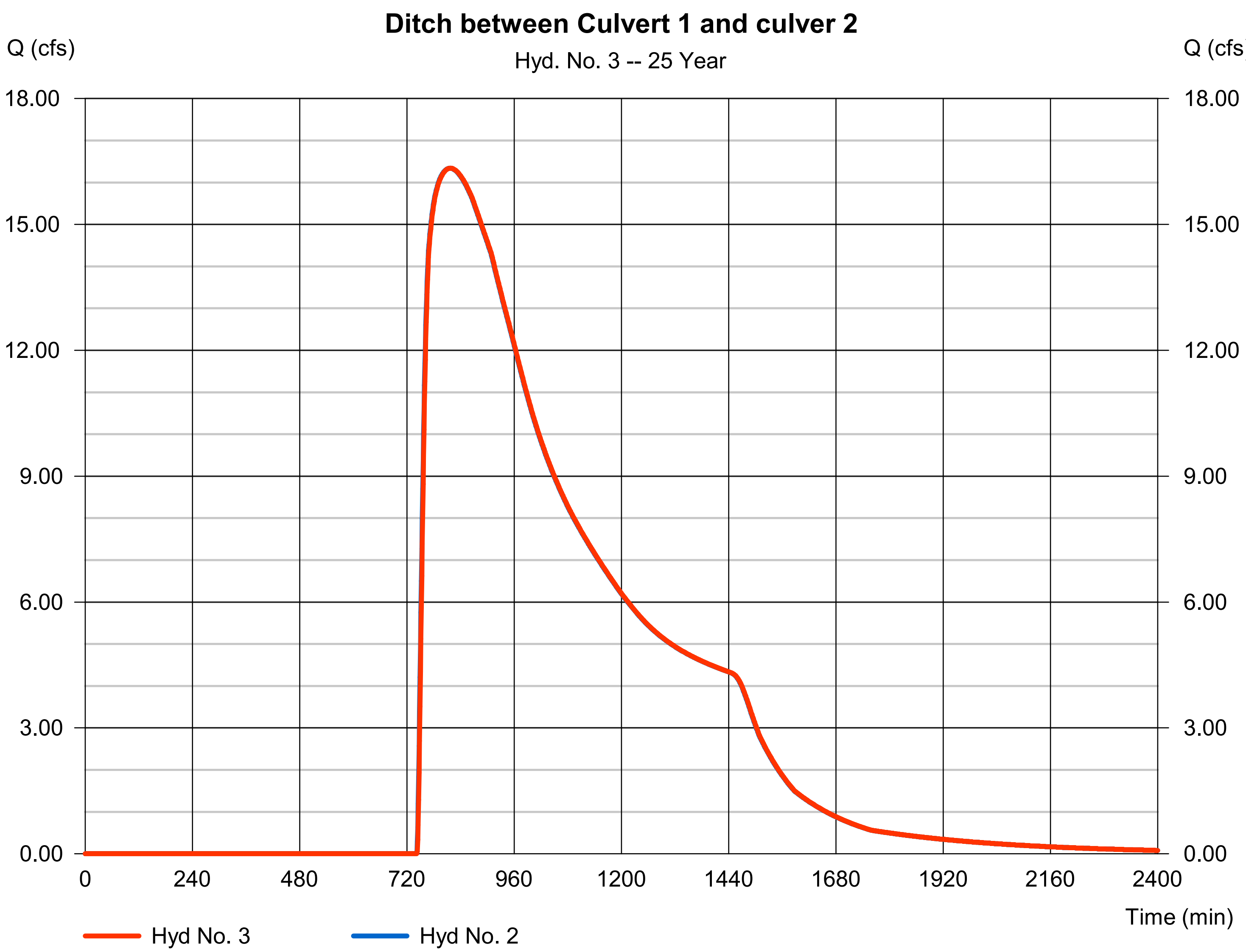
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 16.34 cfs
Storm frequency	= 25 yrs	Time to peak	= 817 min
Time interval	= 1 min	Hyd. volume	= 427,358 cuft
Inflow hyd. No.	= 2 - Pond	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.1954

Modified Att-Kin routing method used.



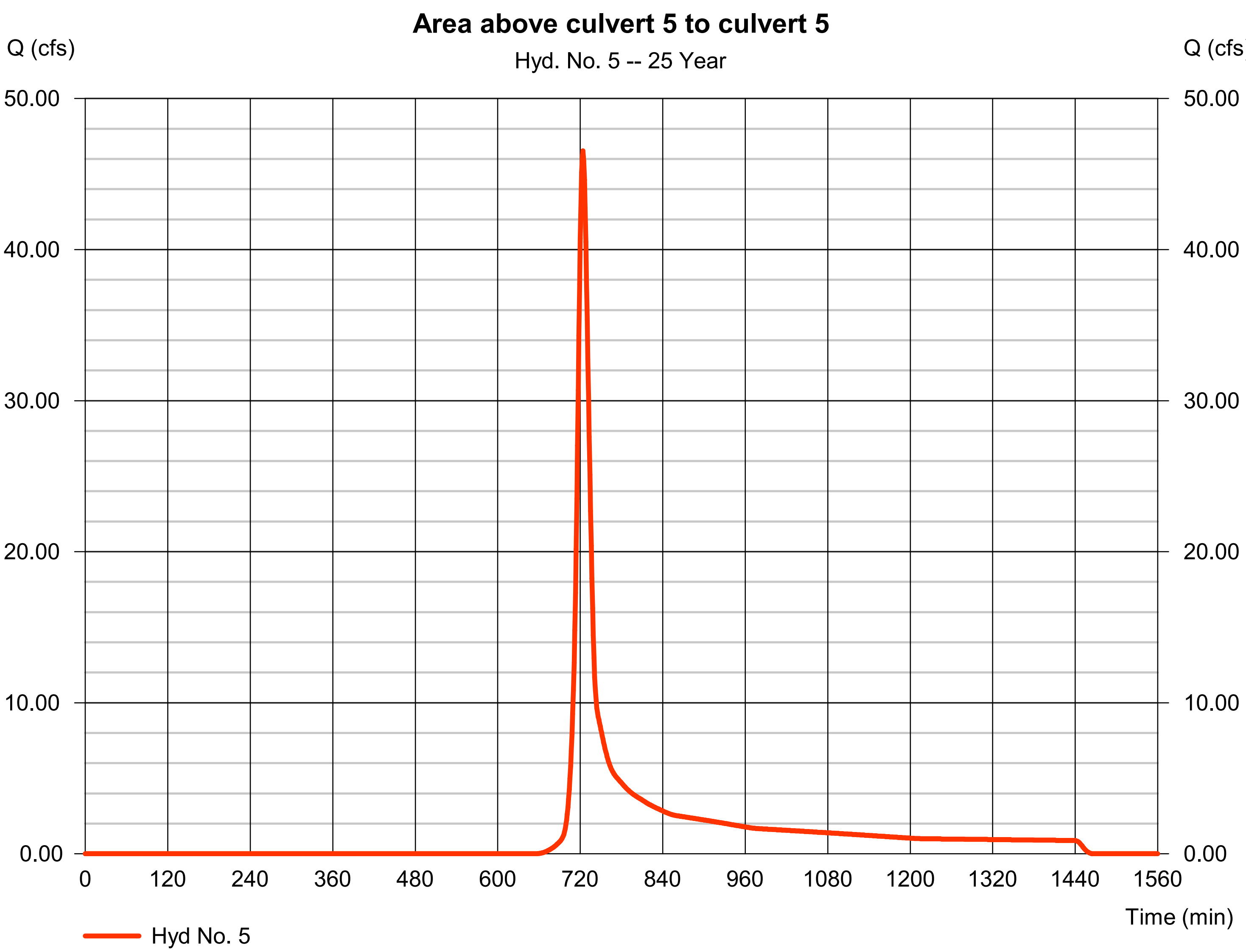
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 46.54 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 138,852 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



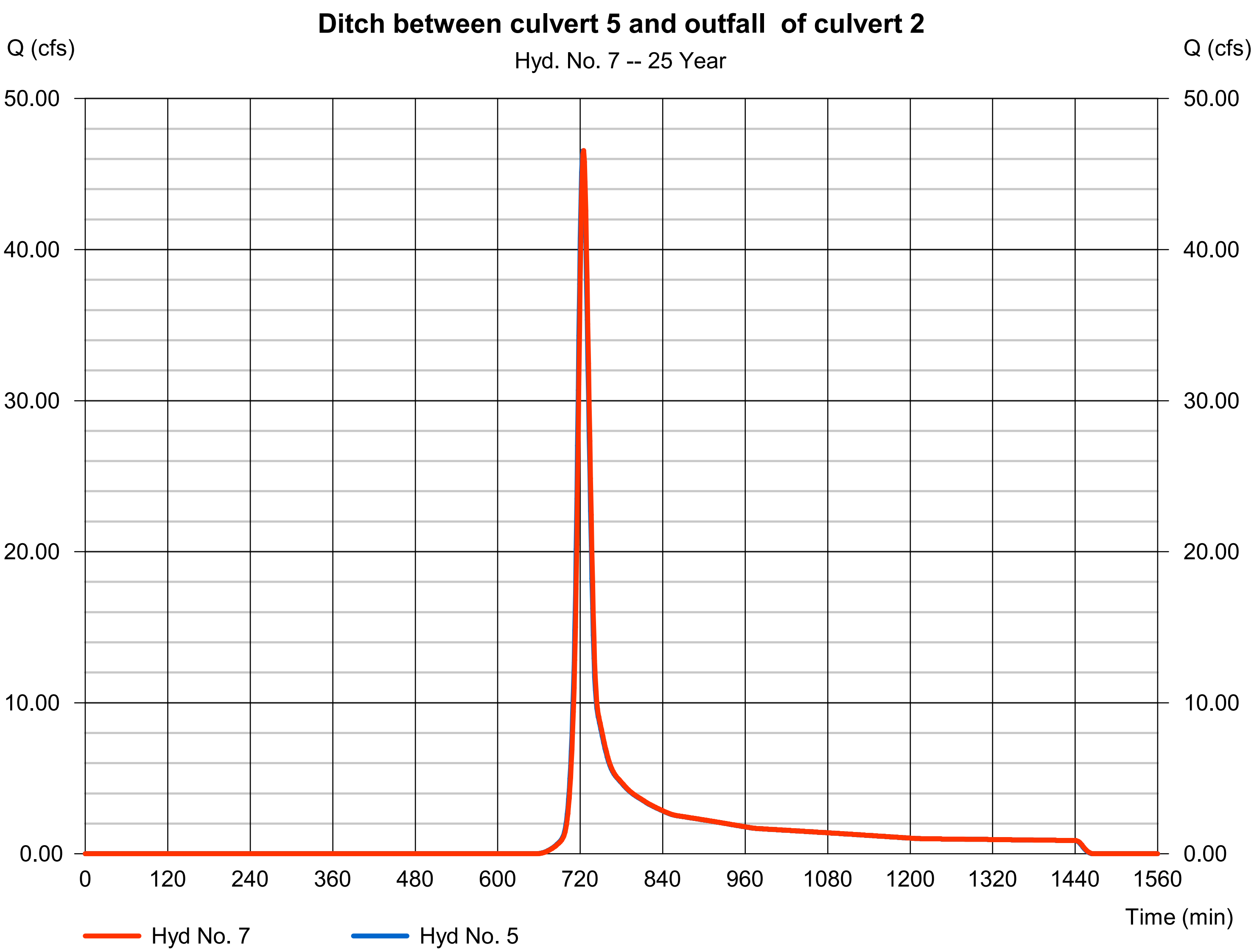
Hydrograph Report

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 46.56 cfs
Storm frequency	= 25 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 138,852 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.1154

Modified Att-Kin routing method used.



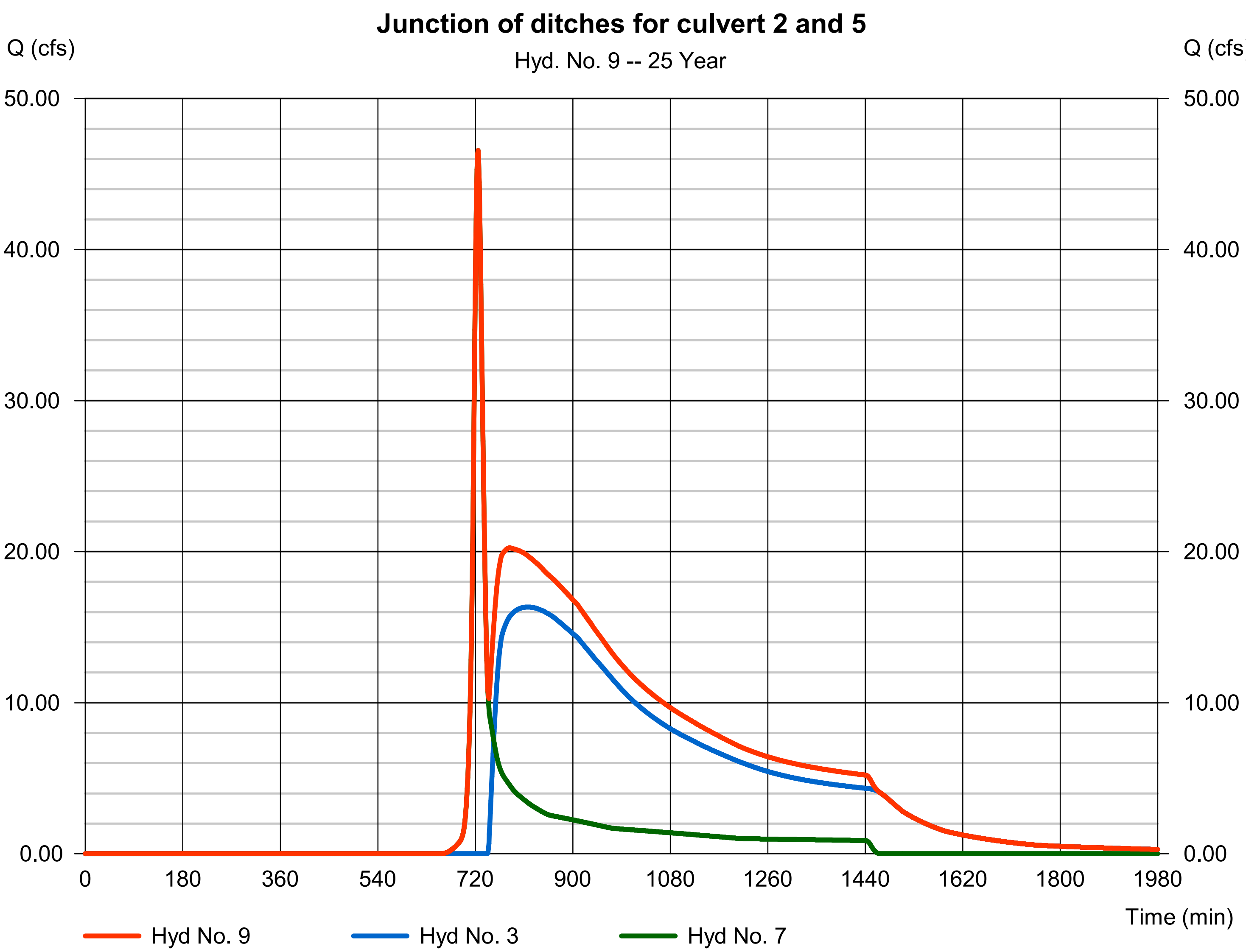
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 46.56 cfs
Storm frequency	= 25 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 566,209 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

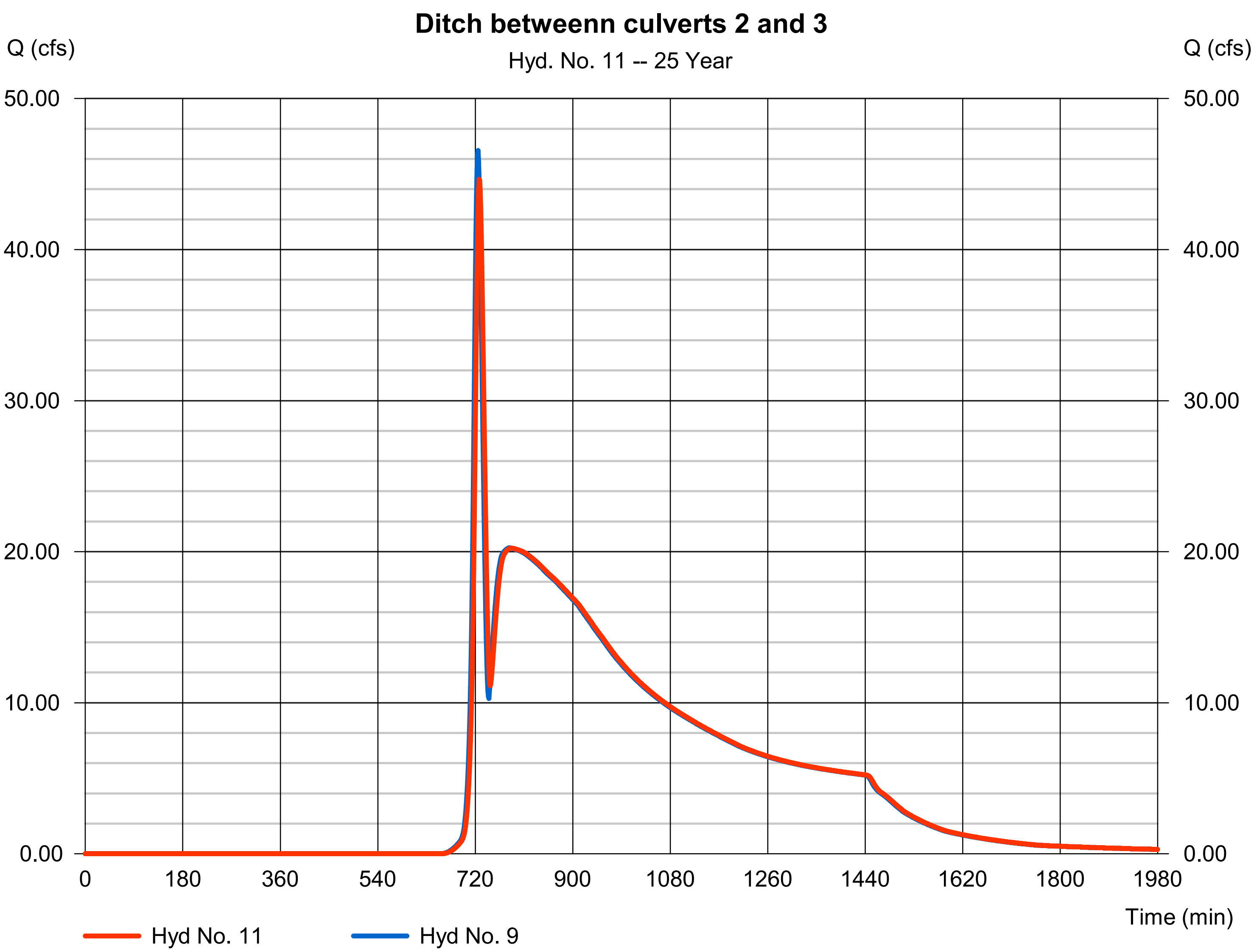
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 44.65 cfs
Storm frequency	= 25 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 566,200 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.3528

Modified Att-Kin routing method used.



Hydrograph Report

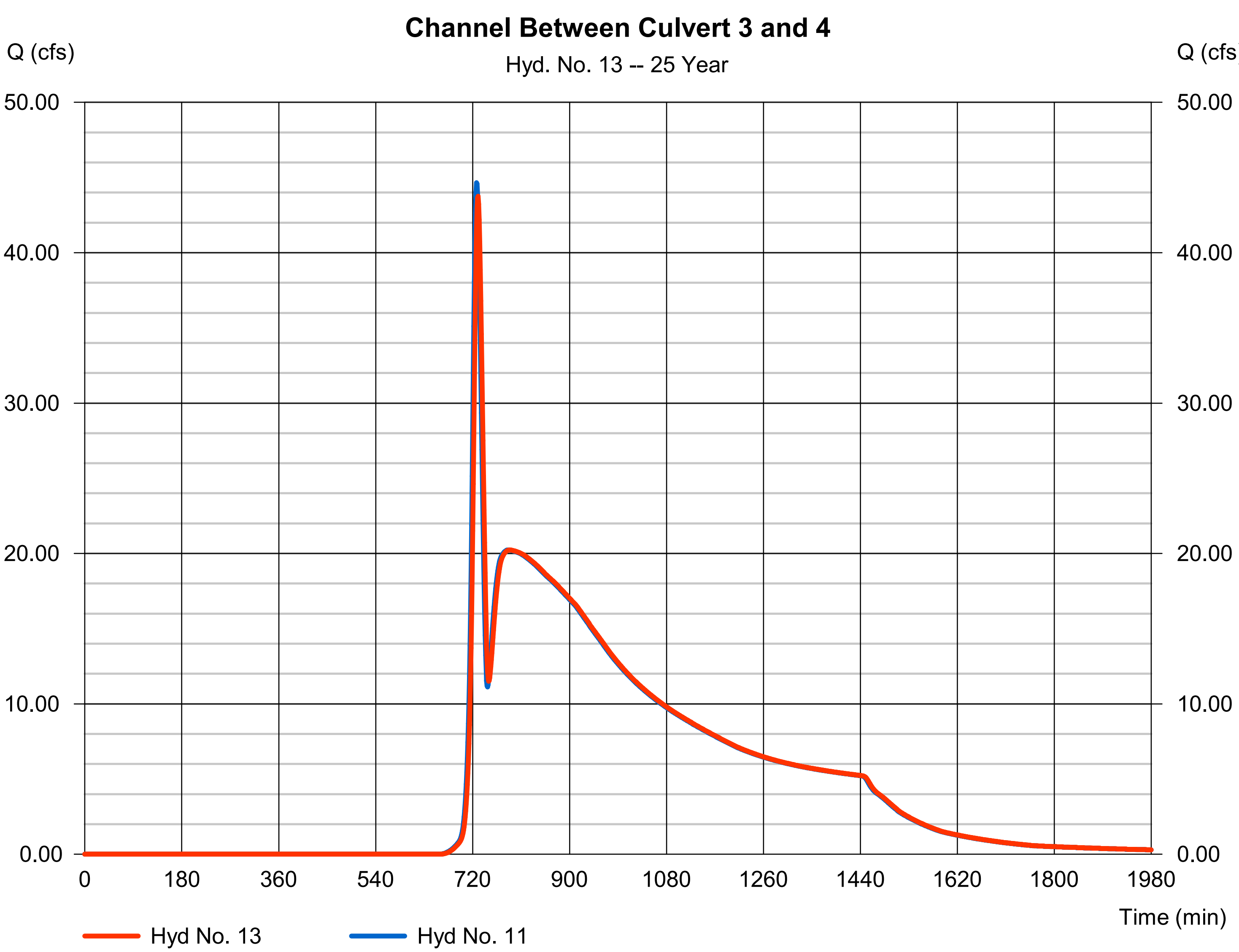
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 43.75 cfs
Storm frequency	= 25 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 566,192 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.4436

Modified Att-Kin routing method used.



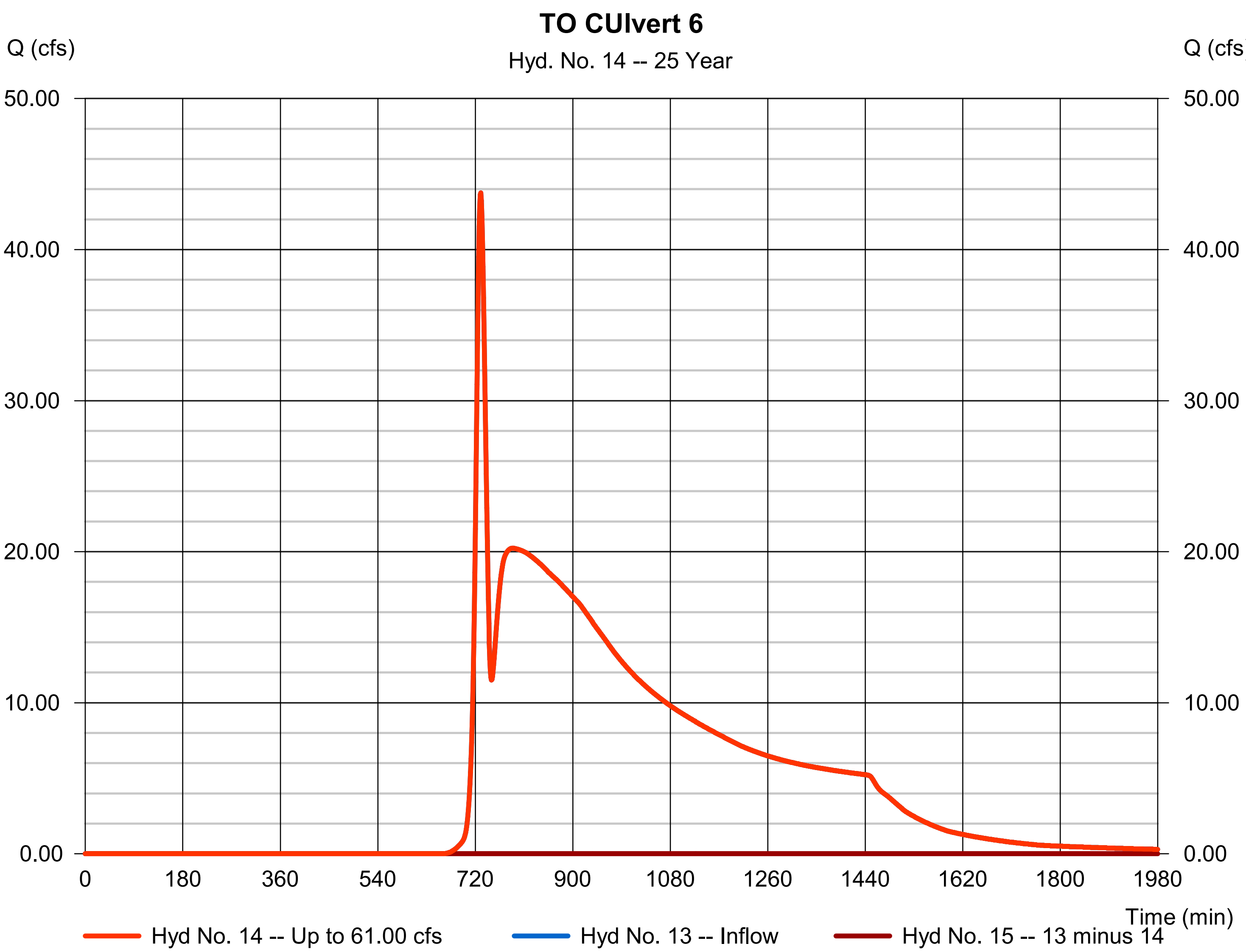
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 14

TO CUlvert 6

Hydrograph type	= Diversion1	Peak discharge	= 43.75 cfs
Storm frequency	= 25 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 566,192 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 15
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



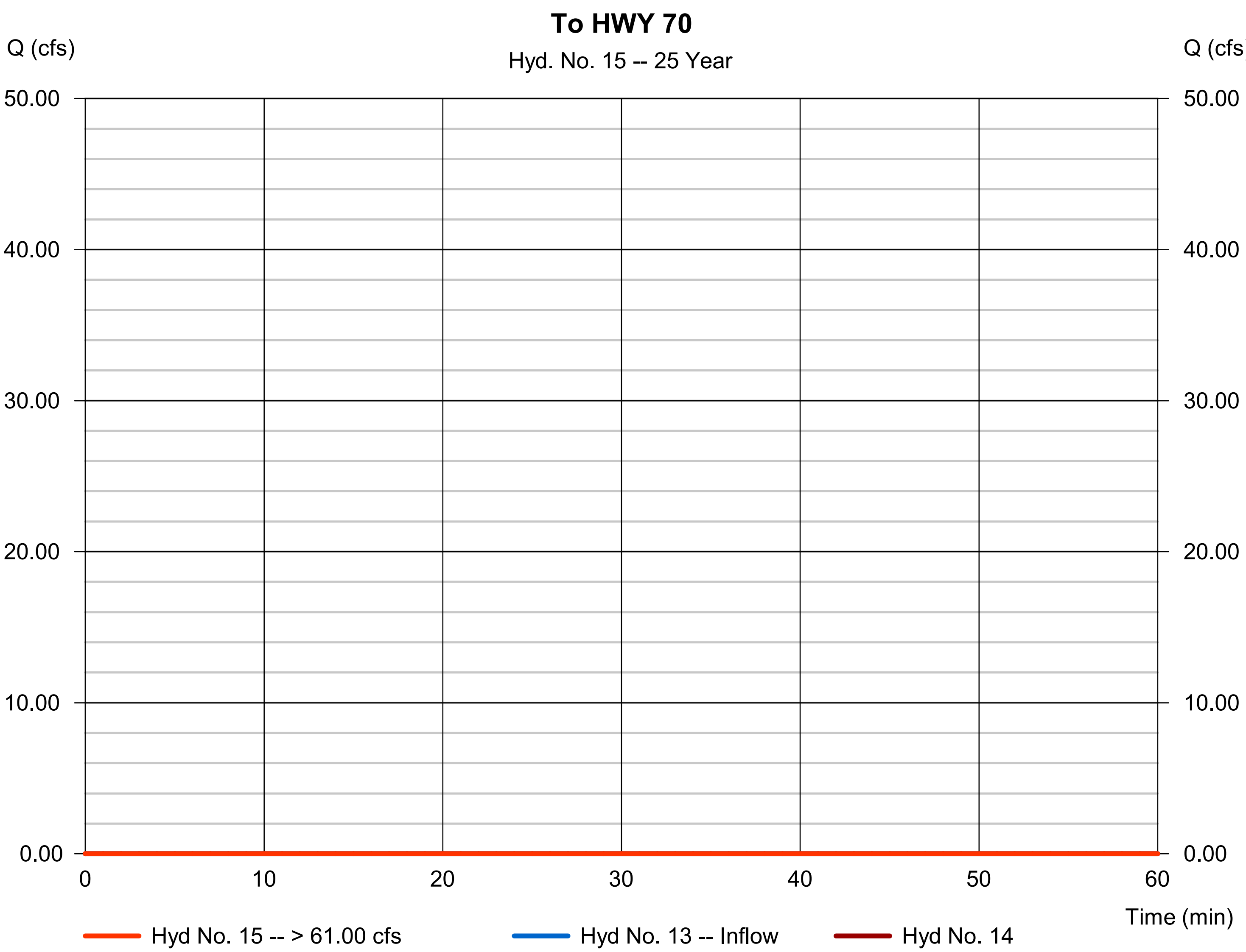
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 15

To HWY 70

Hydrograph type	= Diversion2	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 14
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



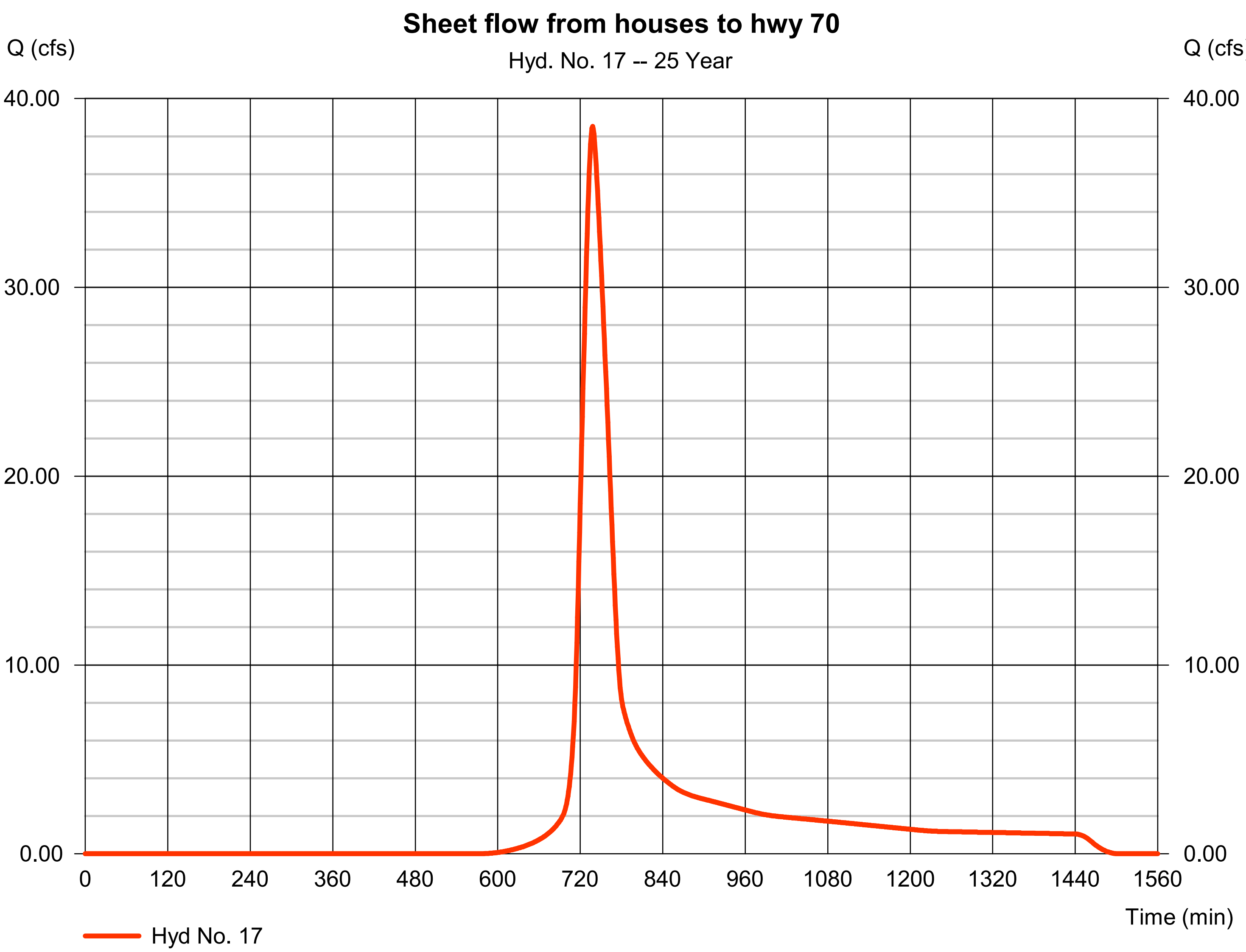
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 17

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 38.53 cfs
Storm frequency	= 25 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 190,584 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.63 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



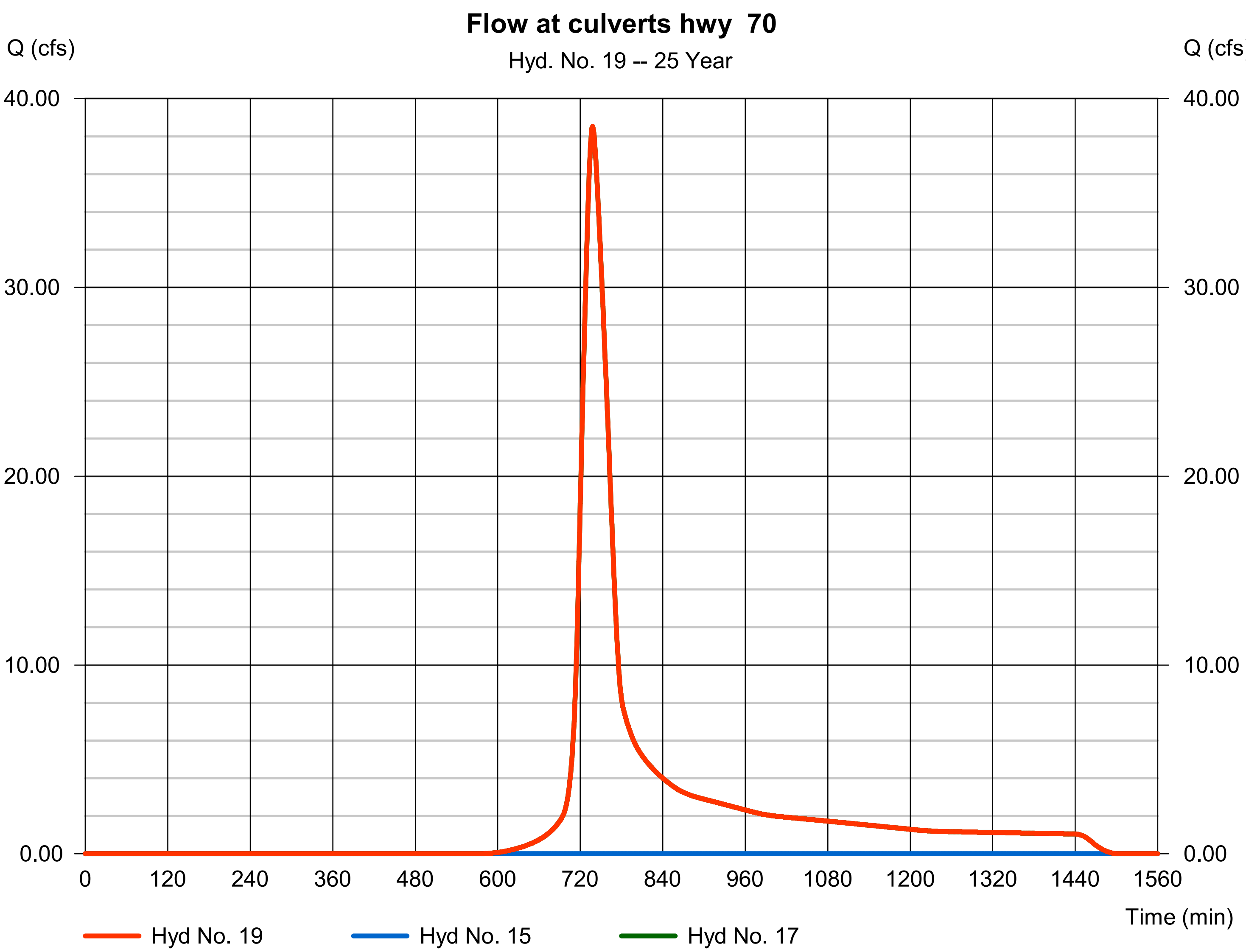
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 19

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 38.53 cfs
Storm frequency	= 25 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 190,584 cuft
Inflow hyds.	= 15, 17	Contrib. drain. area	= 20.330 ac



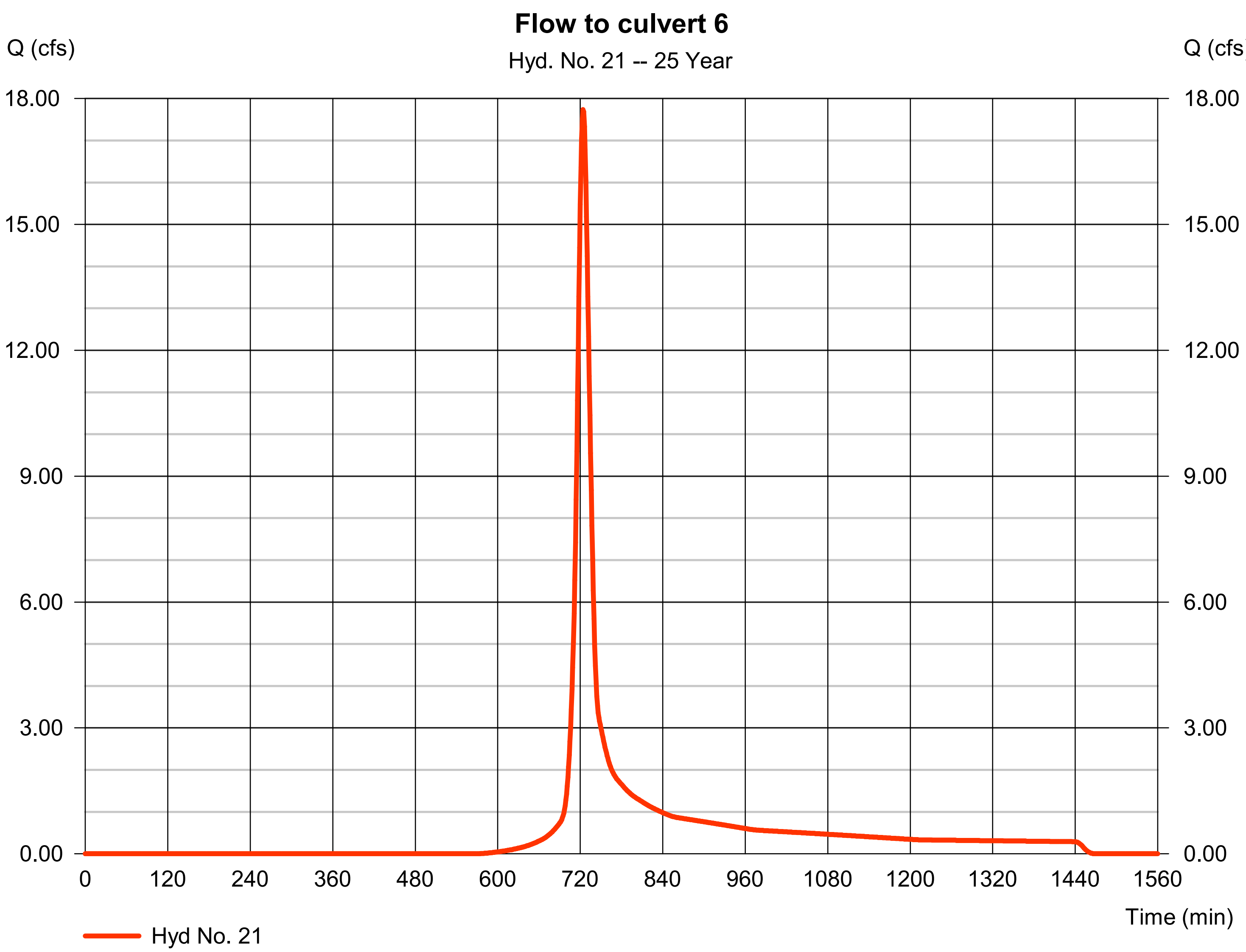
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 21

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 17.74 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 53,013 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 5.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



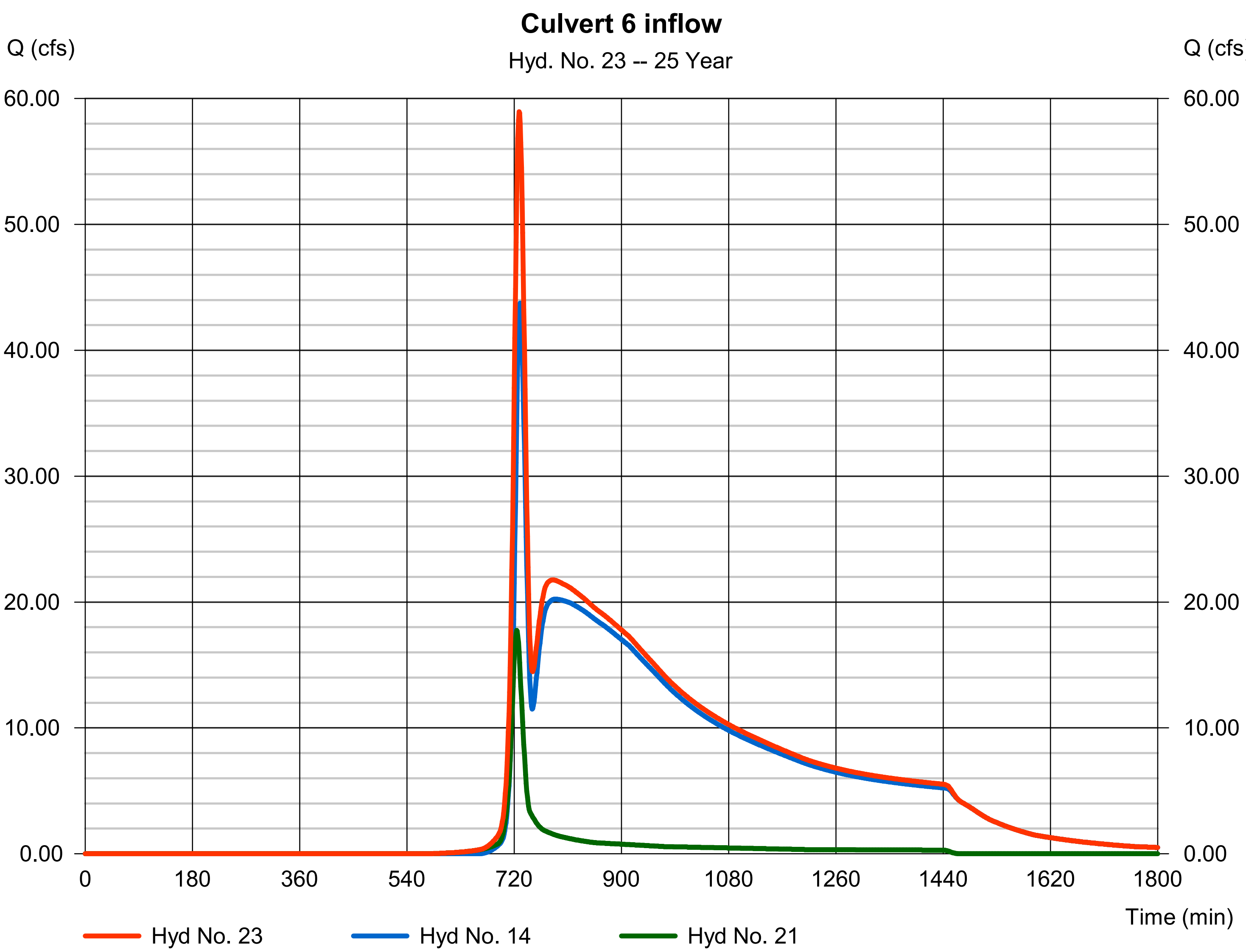
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 23

Culvert 6 inflow

Hydrograph type	= Combine	Peak discharge	= 58.95 cfs
Storm frequency	= 25 yrs	Time to peak	= 728 min
Time interval	= 1 min	Hyd. volume	= 619,204 cuft
Inflow hyds.	= 14, 21	Contrib. drain. area	= 5.720 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	150.27	1	736	728,353	------	------	------	Area Above Hannah Ford leading to
2	Reservoir	22.21	1	805	586,869	1	41.53	329,191	Pond
3	Reach	22.21	1	806	586,867	2	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	59.46	1	724	174,409	------	------	------	Area above culvert 5 to culvert 5
7	Reach	59.47	1	725	174,409	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	59.47	1	725	761,276	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	57.47	1	727	761,268	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	56.42	1	729	761,260	11	------	------	Channel Between Culvert 3 and 4
14	Diversion1	56.42	1	729	761,260	13	------	------	TO CUlvert 6
15	Diversion2	0.000	1	n/a	0	13	------	------	To HWY 70
17	SCS Runoff	47.37	1	738	232,111	------	------	------	Sheet flow from houses to hwy 70
19	Combine	47.37	1	738	232,111	15, 17,	------	------	Flow at culverts hwy 70
21	SCS Runoff	21.73	1	724	64,564	------	------	------	Flow to culvert 6
23	Combine	75.35	1	728	825,823	14, 21,	------	------	Culvert 6 inflow

Diversion analysis with 1 pond (1).gpw	Return Period: 50 Year	Tuesday, 03 / 28 / 2017

Hydrograph Report

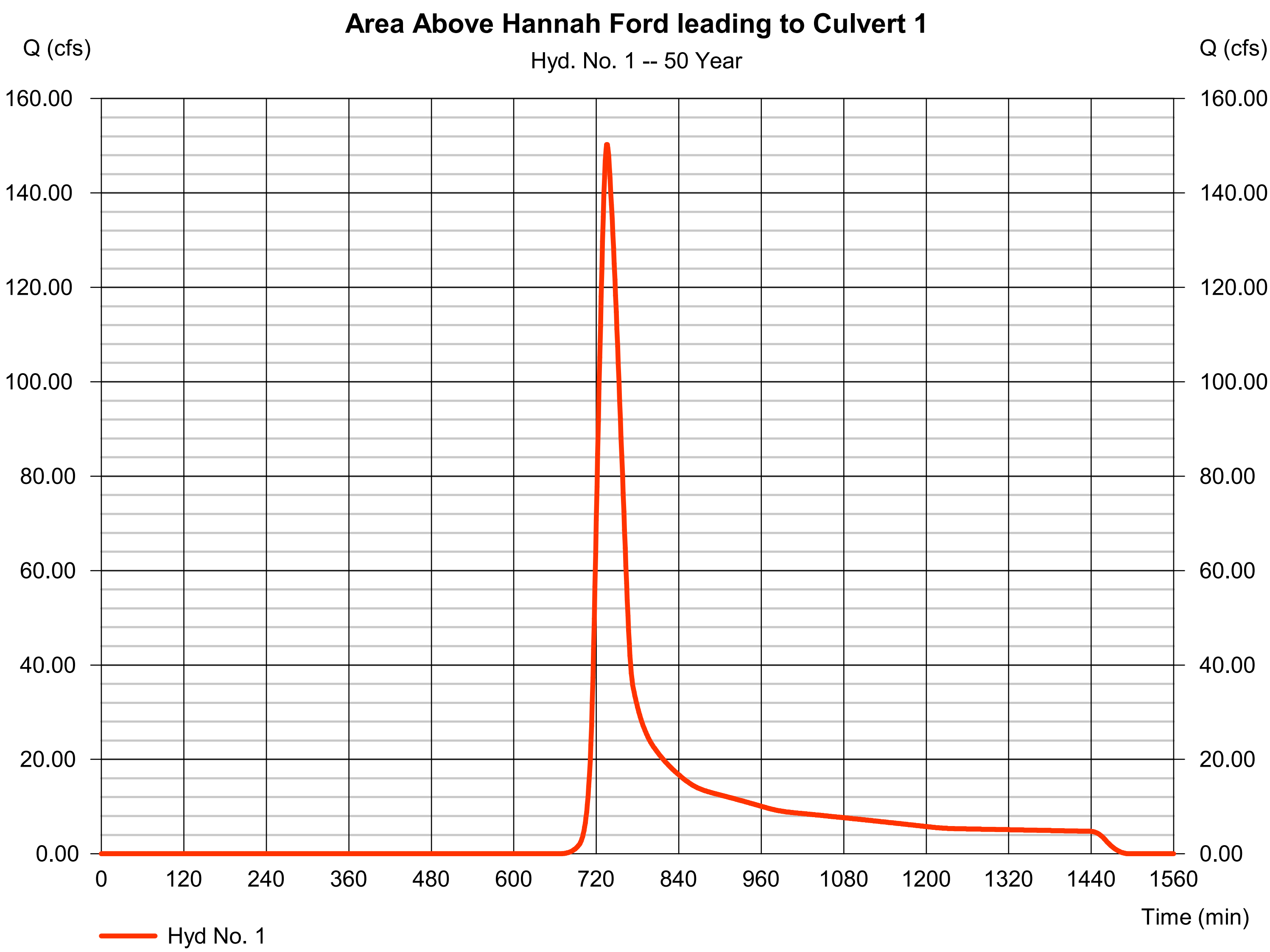
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 | Tuesday, 03 / 28 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 150.27 cfs
Storm frequency	= 50 yrs	Time to peak	= 736 min
Time interval	= 1 min	Hyd. volume	= 728,353 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

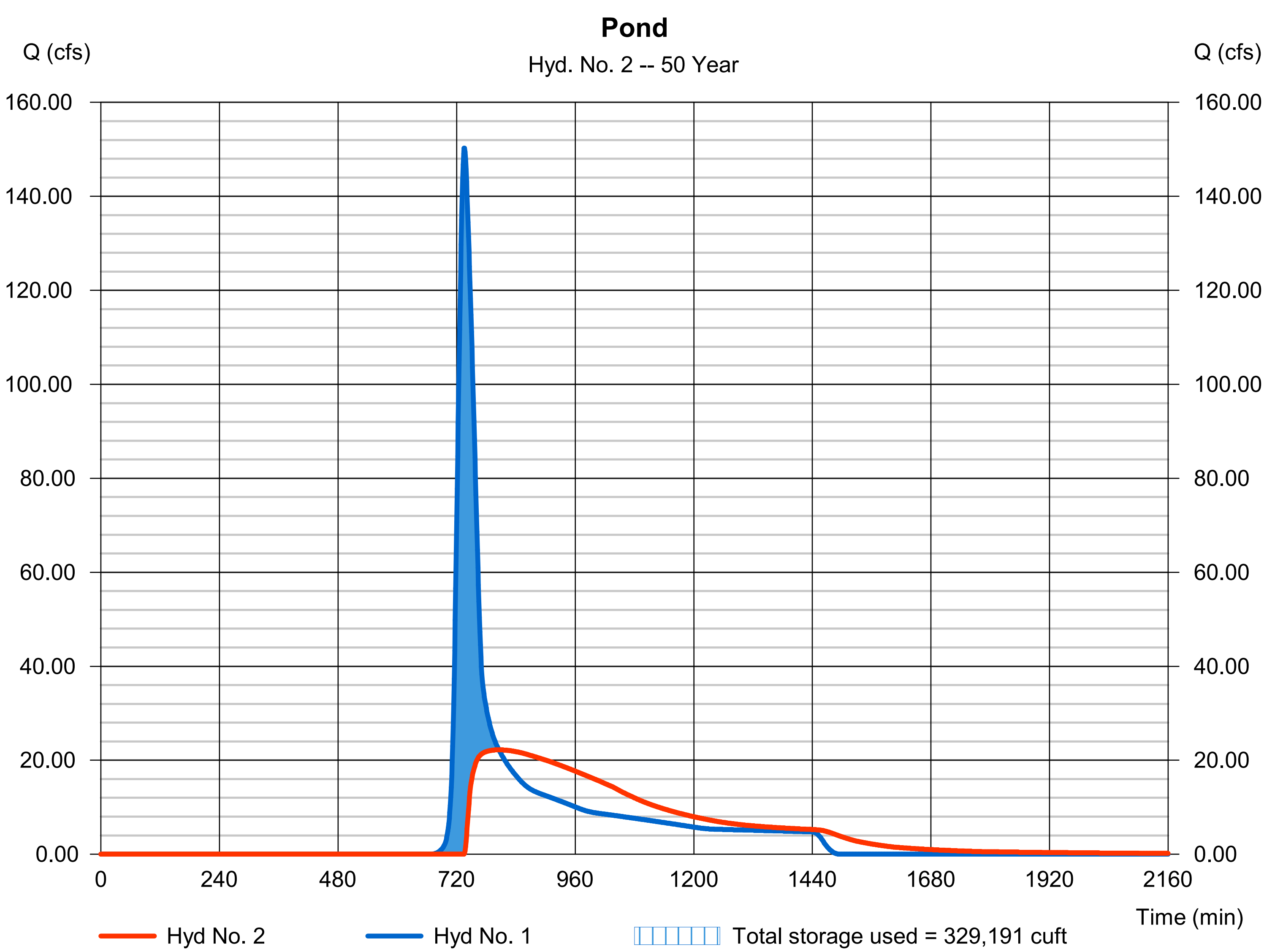
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 2

Pond

Hydrograph type	= Reservoir	Peak discharge	= 22.21 cfs
Storm frequency	= 50 yrs	Time to peak	= 805 min
Time interval	= 1 min	Hyd. volume	= 586,869 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Max. Elevation	= 41.53 ft
Reservoir name	= Pond Paired with Diversion	Max. Storage	= 329,191 cuft

Storage Indication method used.



Hydrograph Report

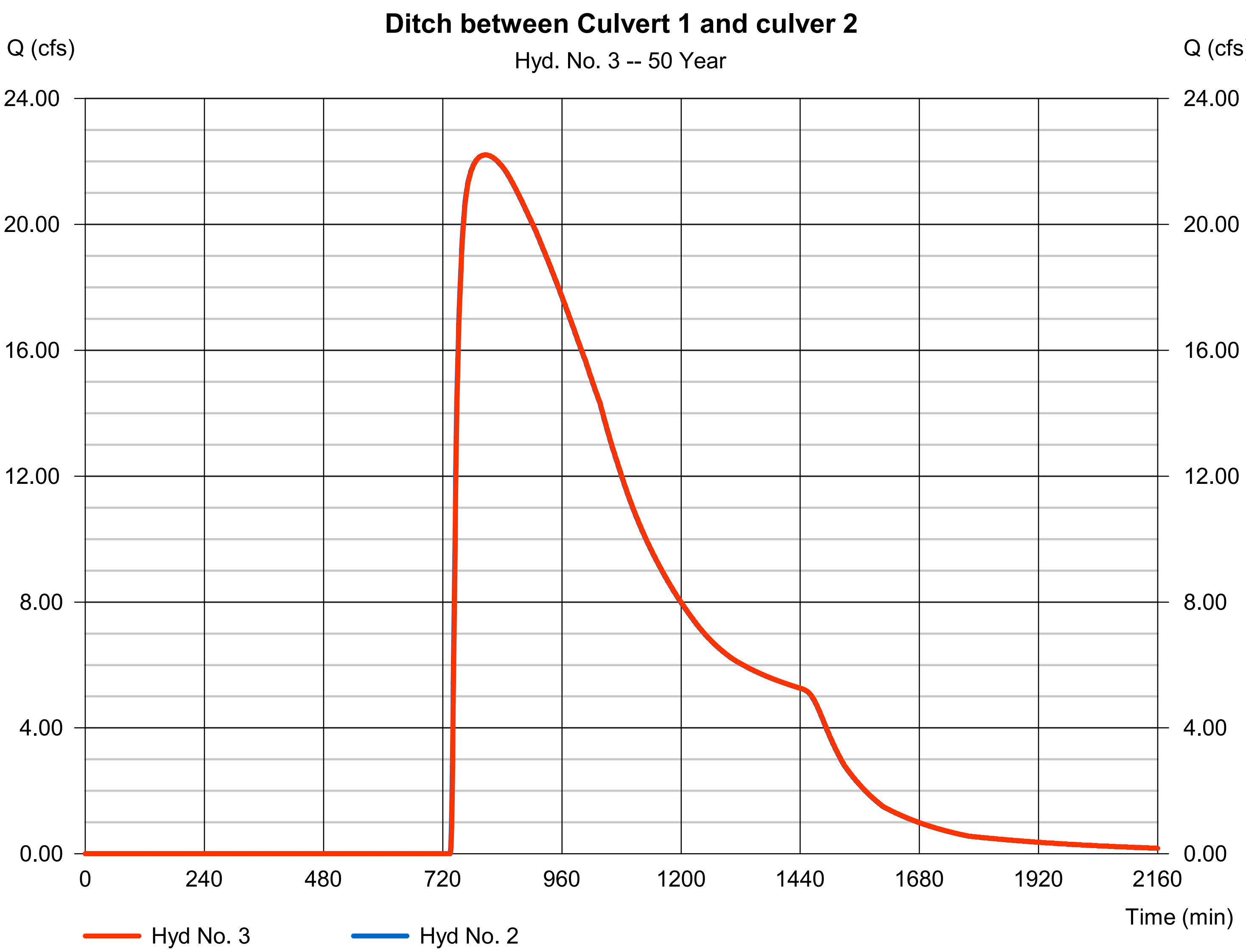
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 22.21 cfs
Storm frequency	= 50 yrs	Time to peak	= 806 min
Time interval	= 1 min	Hyd. volume	= 586,867 cuft
Inflow hyd. No.	= 2 - Pond	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.2274

Modified Att-Kin routing method used.



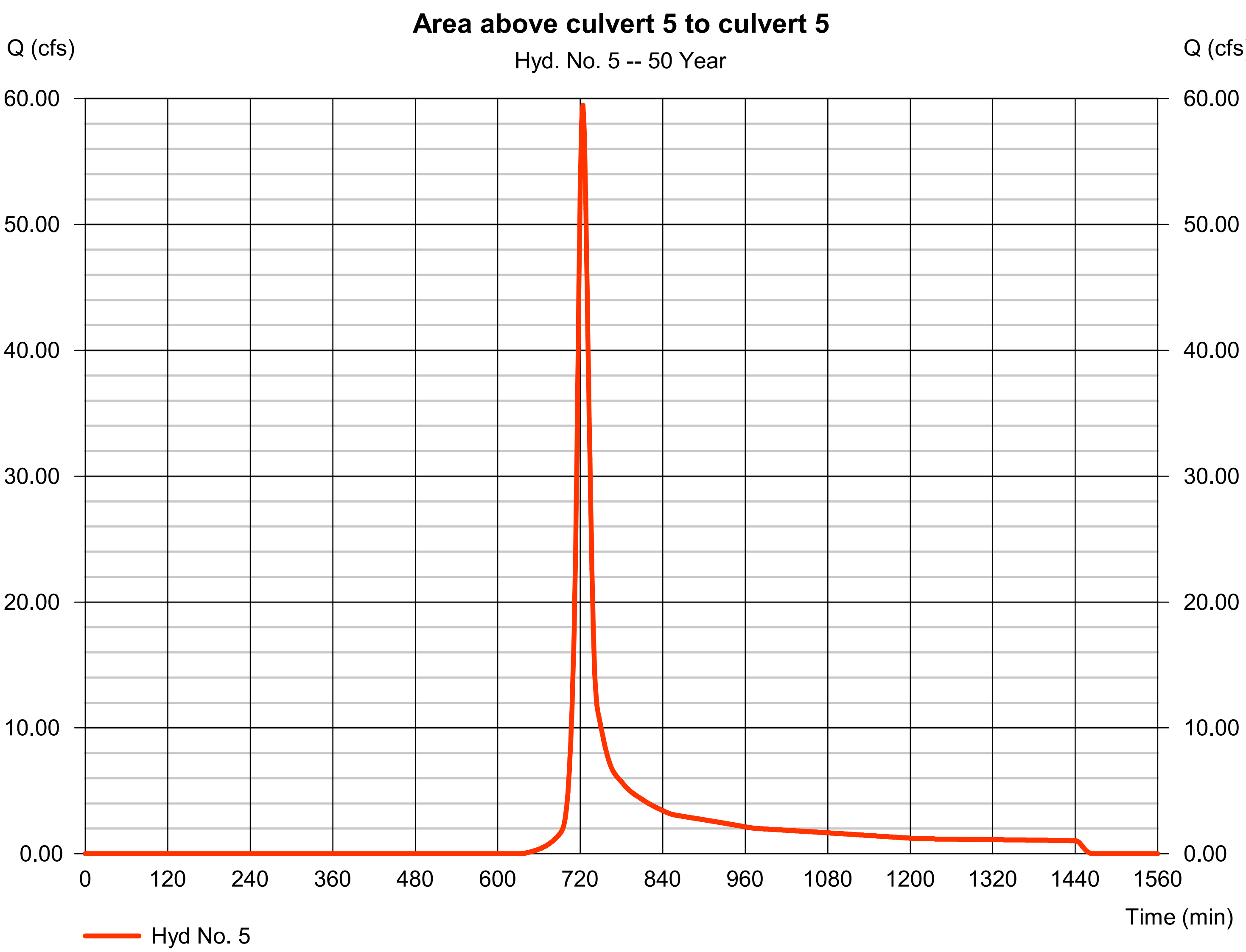
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 59.46 cfs
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 174,409 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

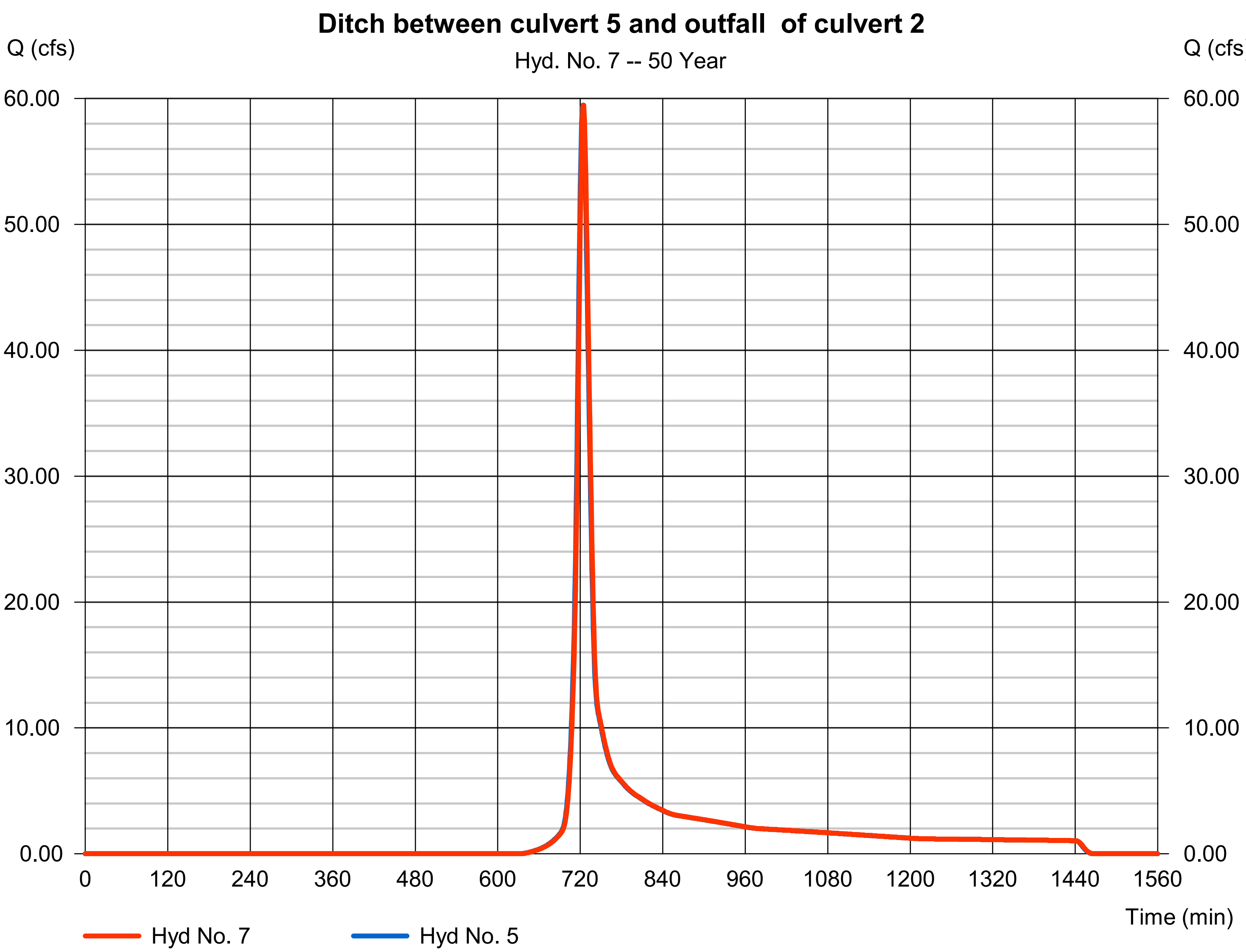
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 59.47 cfs
Storm frequency	= 50 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 174,409 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.1395

Modified Att-Kin routing method used.



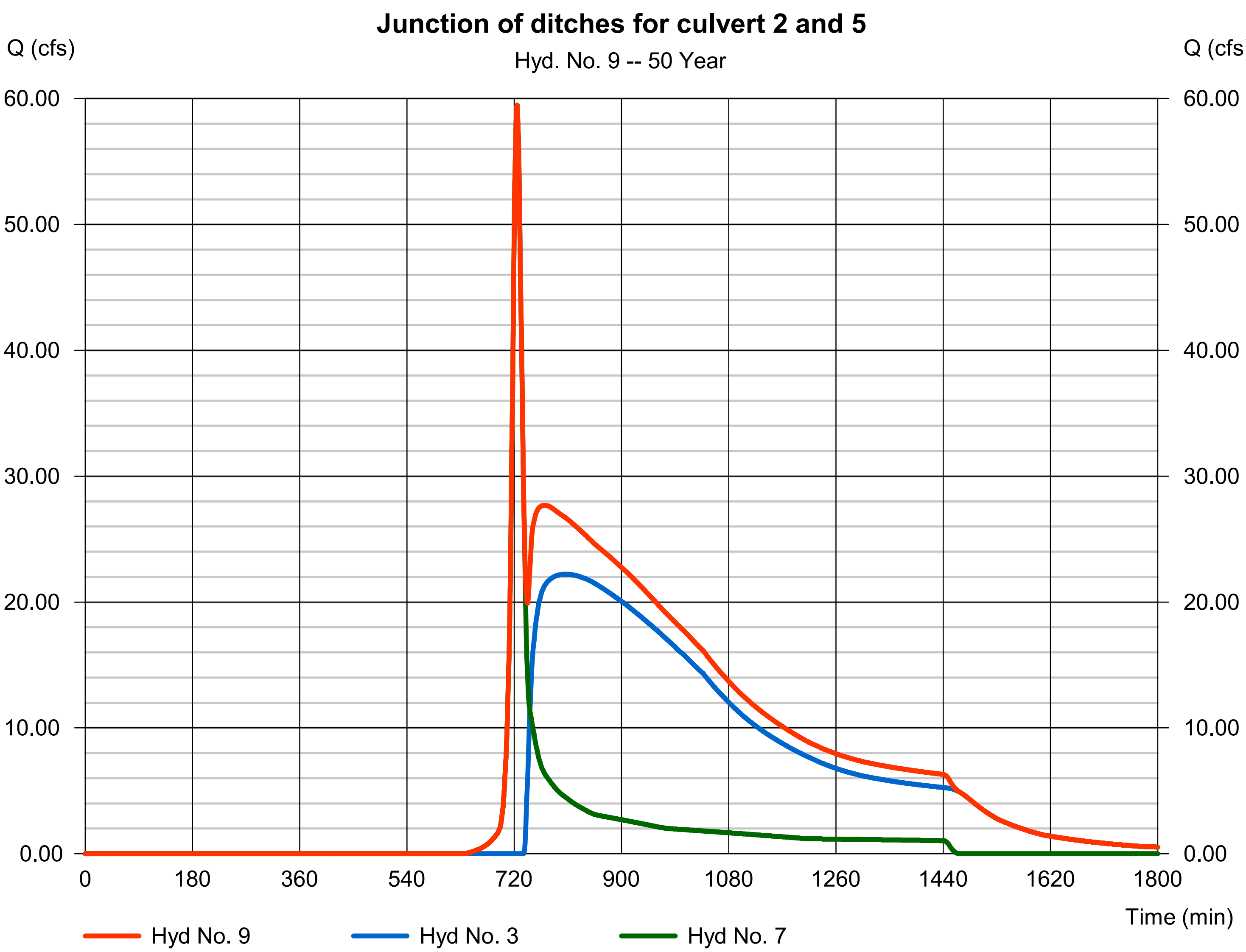
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 59.47 cfs
Storm frequency	= 50 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 761,276 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

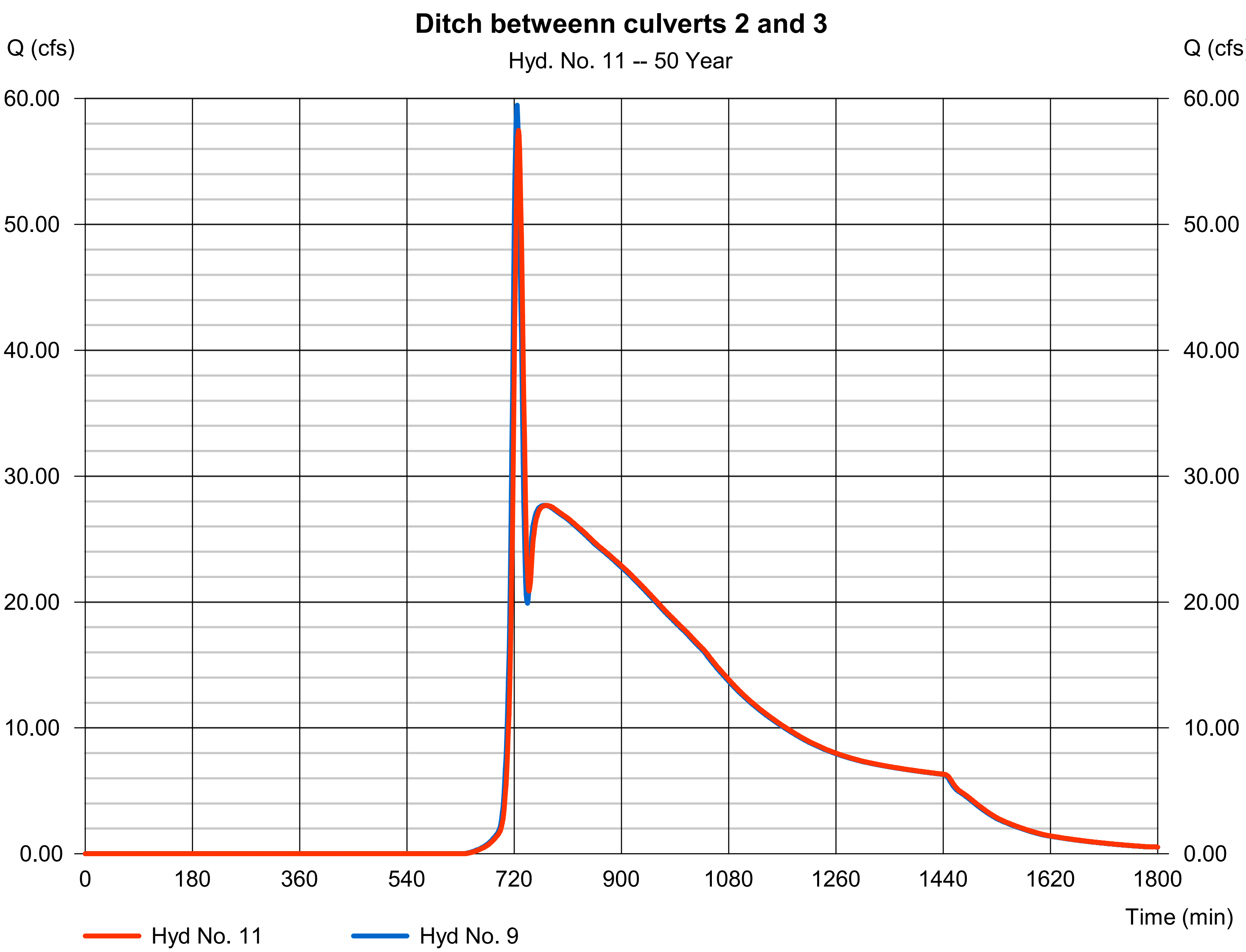
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 57.47 cfs
Storm frequency	= 50 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 761,268 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culvert 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.3713

Modified Att-Kin routing method used.



Hydrograph Report

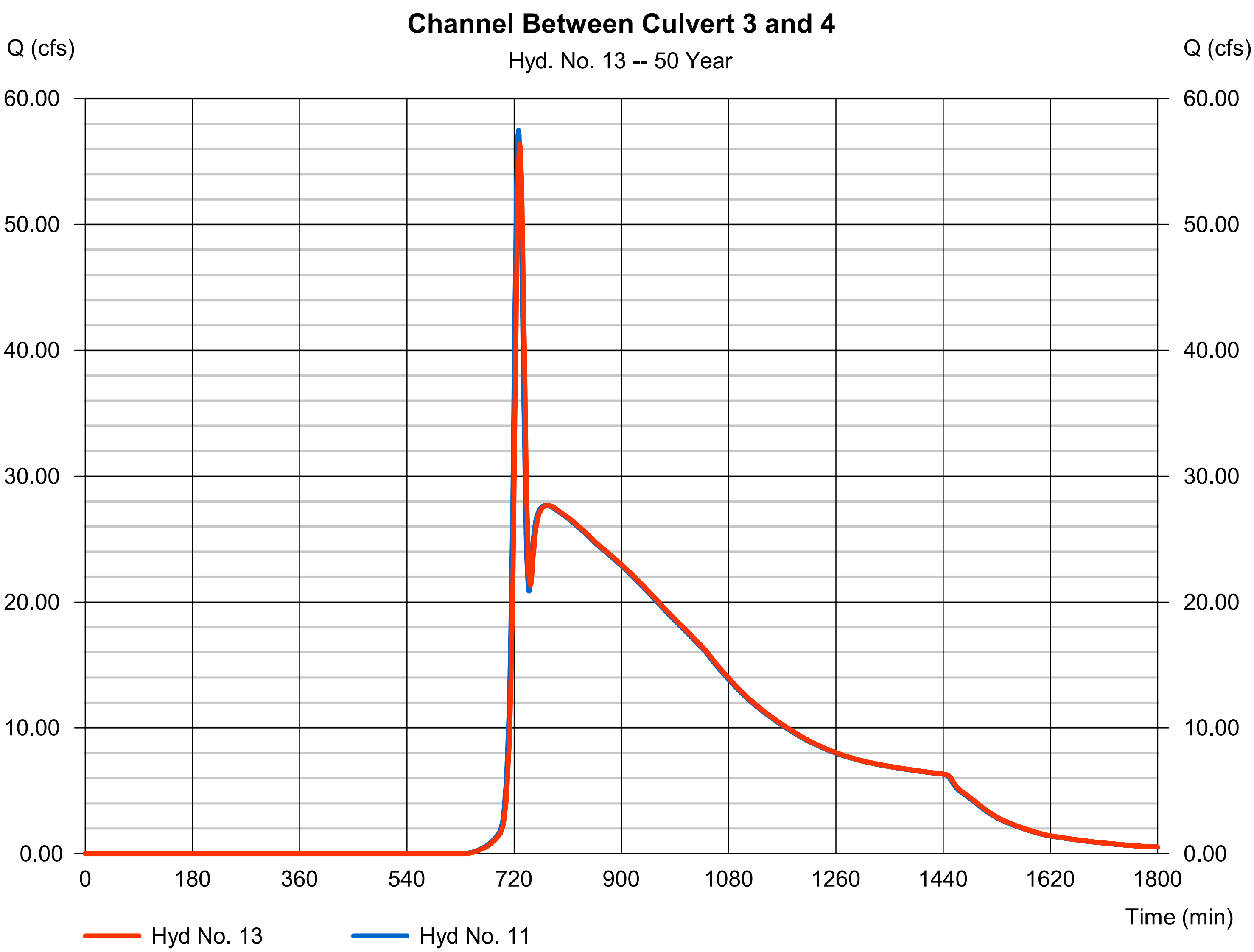
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 56.42 cfs
Storm frequency	= 50 yrs	Time to peak	= 729 min
Time interval	= 1 min	Hyd. volume	= 761,260 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.4652

Modified Att-Kin routing method used.



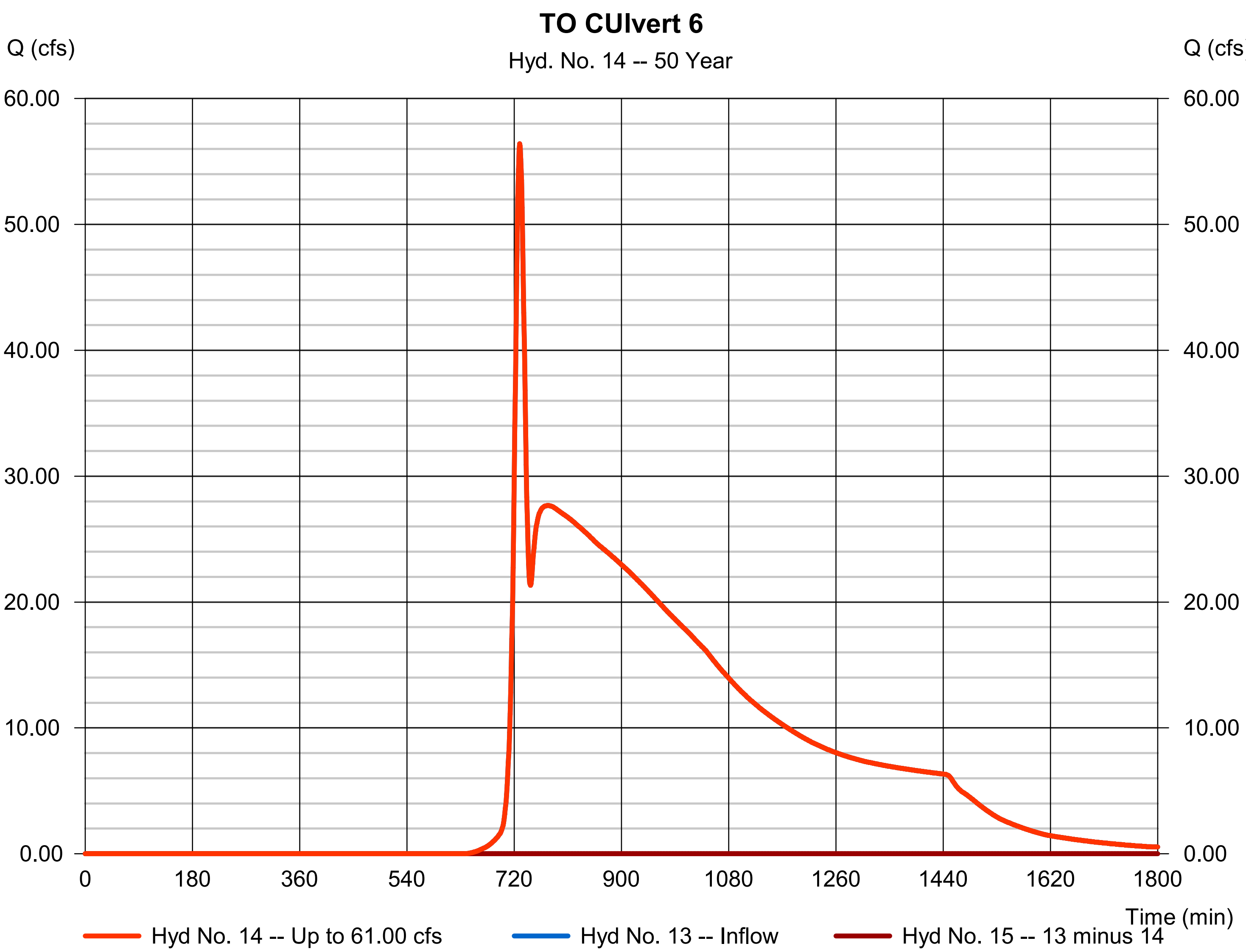
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 14

TO CUlvert 6

Hydrograph type	= Diversion1	Peak discharge	= 56.42 cfs
Storm frequency	= 50 yrs	Time to peak	= 729 min
Time interval	= 1 min	Hyd. volume	= 761,260 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 15
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



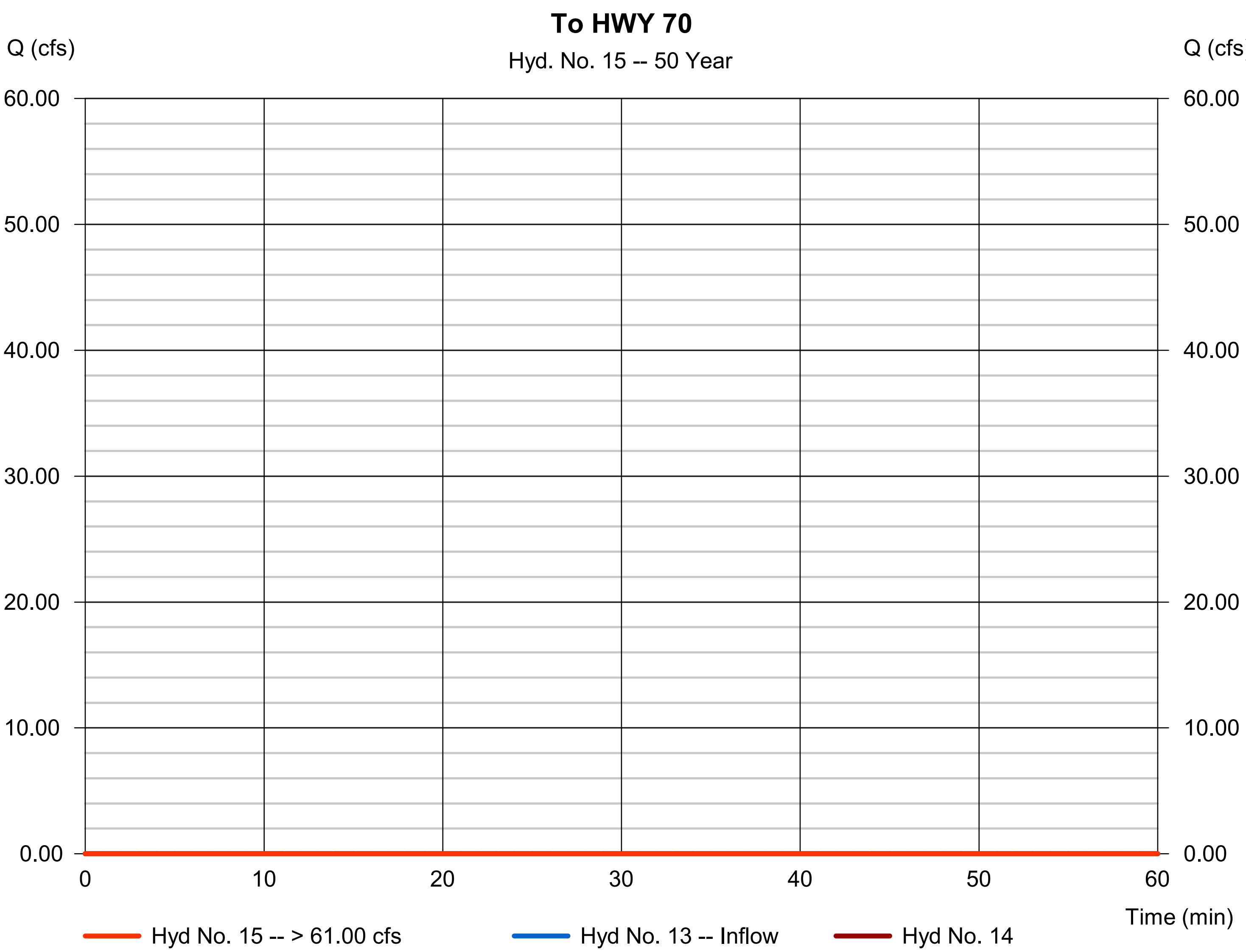
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 15

To HWY 70

Hydrograph type	= Diversion2	Peak discharge	= 0.000 cfs
Storm frequency	= 50 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 14
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



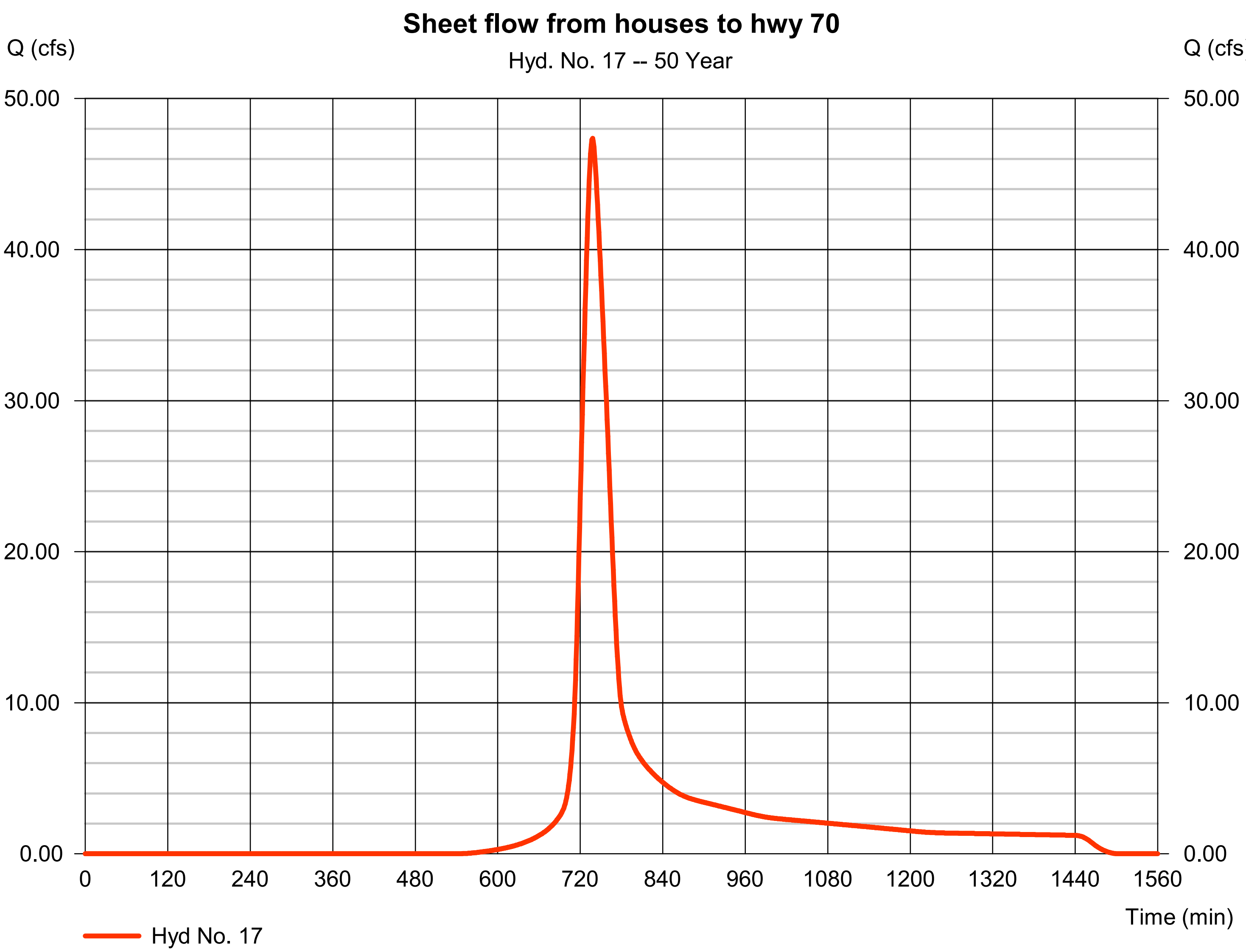
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 17

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 47.37 cfs
Storm frequency	= 50 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 232,111 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.63 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



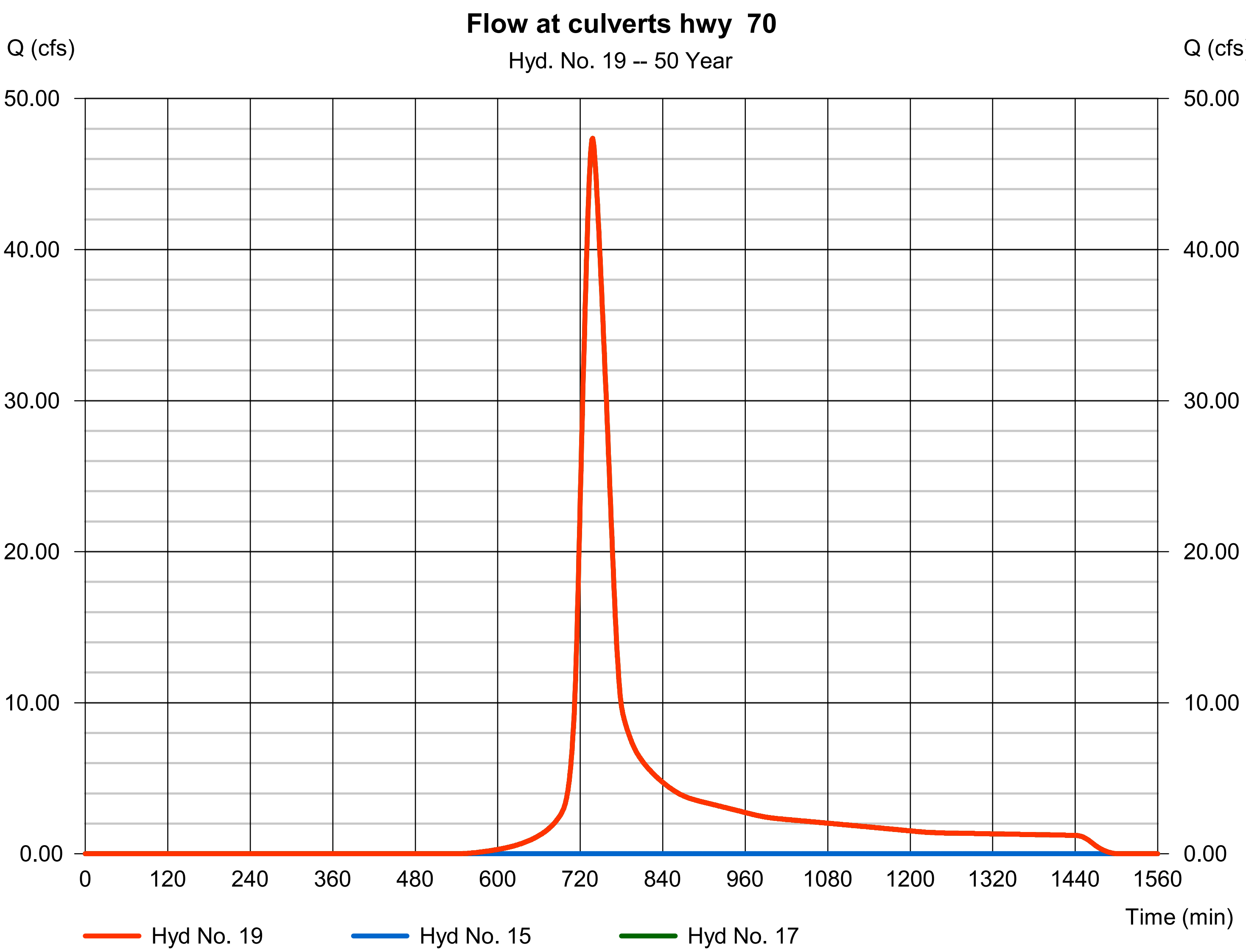
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 19

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 47.37 cfs
Storm frequency	= 50 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 232,111 cuft
Inflow hyds.	= 15, 17	Contrib. drain. area	= 20.330 ac



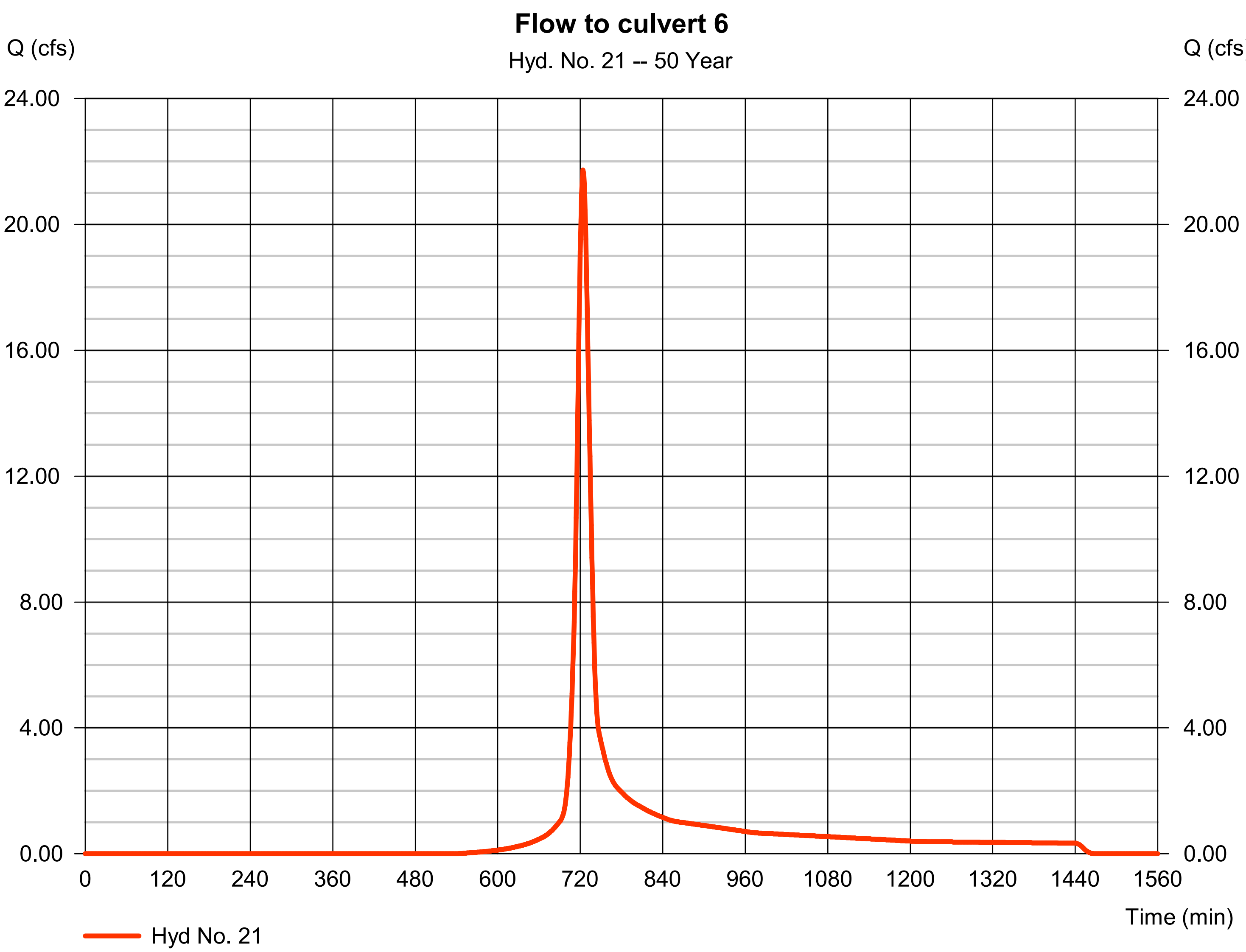
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 21

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 21.73 cfs
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 64,564 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



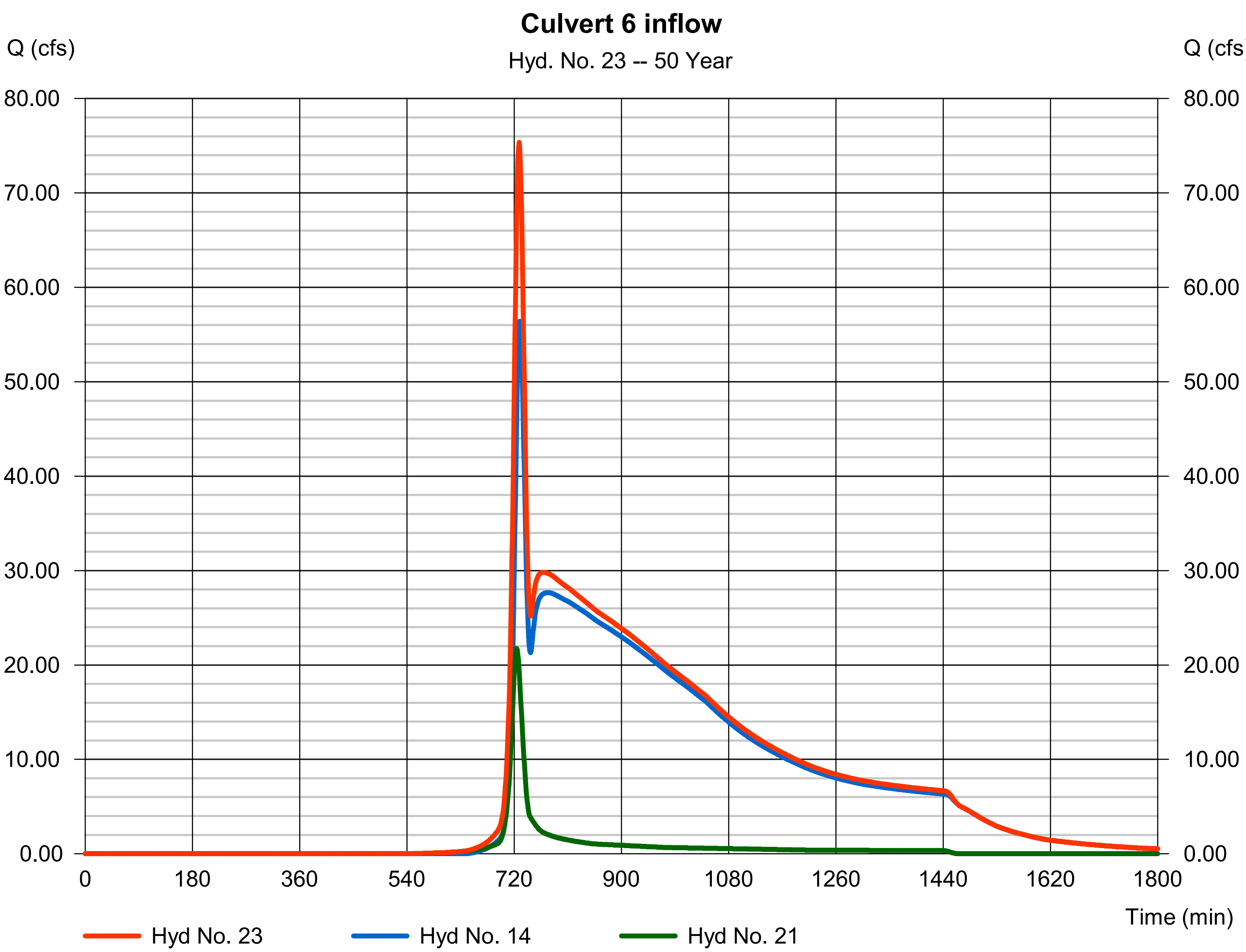
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 23

Culvert 6 inflow

Hydrograph type	= Combine	Peak discharge	= 75.35 cfs
Storm frequency	= 50 yrs	Time to peak	= 728 min
Time interval	= 1 min	Hyd. volume	= 825,823 cuft
Inflow hyds.	= 14, 21	Contrib. drain. area	= 5.720 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	192.30	1	735	905,950	------	------	------	Area Above Hannah Ford leading to
2	Reservoir	33.89	1	786	764,408	1	42.76	407,688	Pond
3	Reach	33.89	1	787	764,404	2	------	------	Ditch between Culvert 1 and culver 2
5	SCS Runoff	73.57	1	724	213,534	------	------	------	Area above culvert 5 to culvert 5
7	Reach	73.68	1	724	213,534	5	------	------	Ditch between culvert 5 and outfall of
9	Combine	73.68	1	724	977,938	3, 7,	------	------	Junction of ditches for culvert 2 and 5
11	Reach	71.45	1	727	977,931	9	------	------	Ditch betweenn culverts 2 and 3
13	Reach	70.31	1	729	977,924	11	------	------	Channel Between Culvert 3 and 4
14	Diversion1	61.00	1	725	974,637	13	------	------	TO CUlvert 6
15	Diversion2	9.307	1	729	3,287	13	------	------	To HWY 70
17	SCS Runoff	56.85	1	738	276,957	------	------	------	Sheet flow from houses to hwy 70
19	Combine	57.64	1	731	280,027	15, 17,	------	------	Flow at culverts hwy 70
21	SCS Runoff	26.00	1	724	77,038	------	------	------	Flow to culvert 6
23	Combine	87.24	1	725	1,051,892	14, 21,	------	------	Culvert 6 inflow

Hydrograph Report

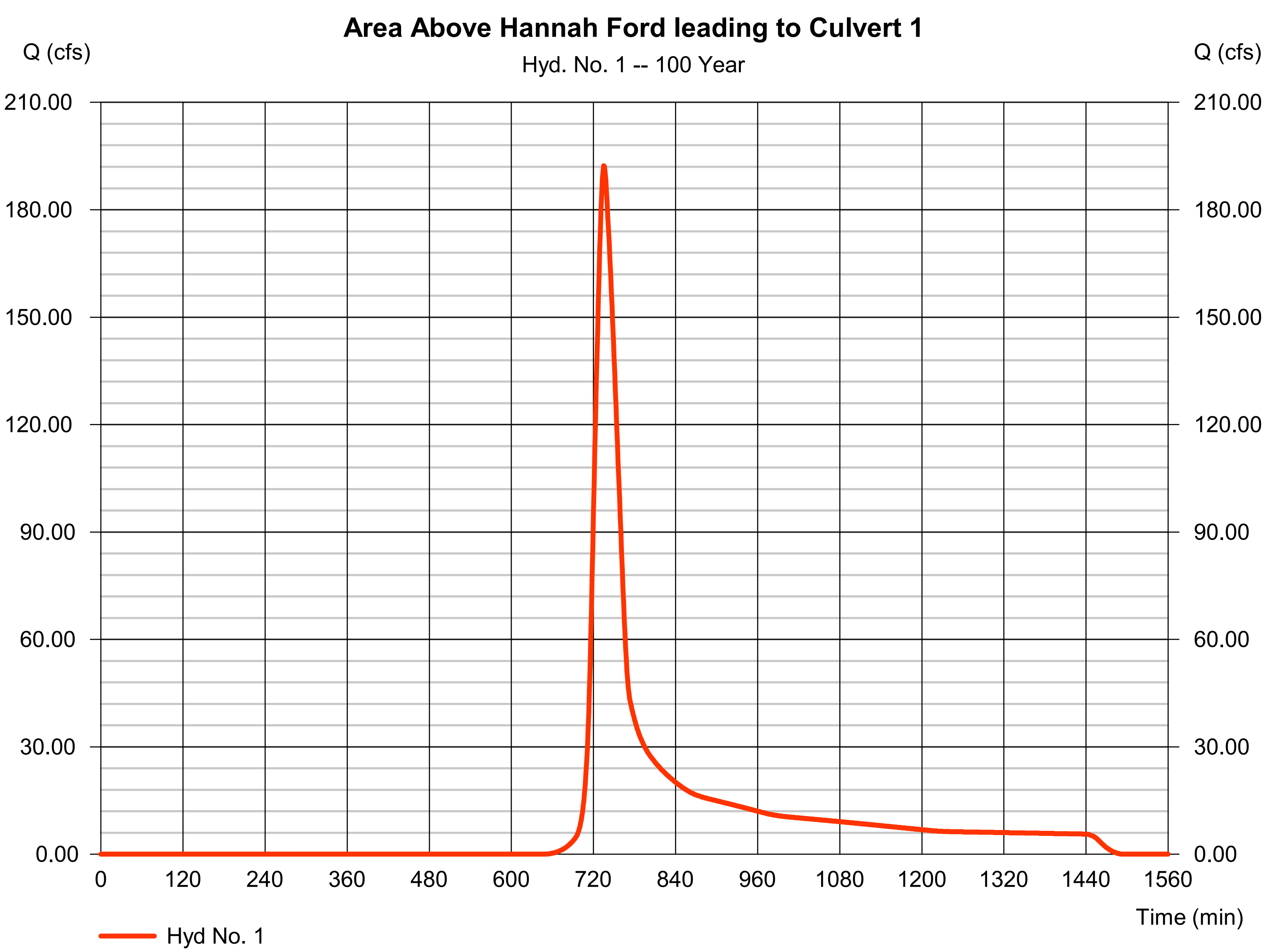
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 1

Area Above Hannah Ford leading to Culvert 1

Hydrograph type	= SCS Runoff	Peak discharge	= 192.30 cfs
Storm frequency	= 100 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 905,950 cuft
Drainage area	= 100.000 ac	Curve number	= 56*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 34.70 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(17.000 x 36) + (83.000 x 60)] / 100.000



Hydrograph Report

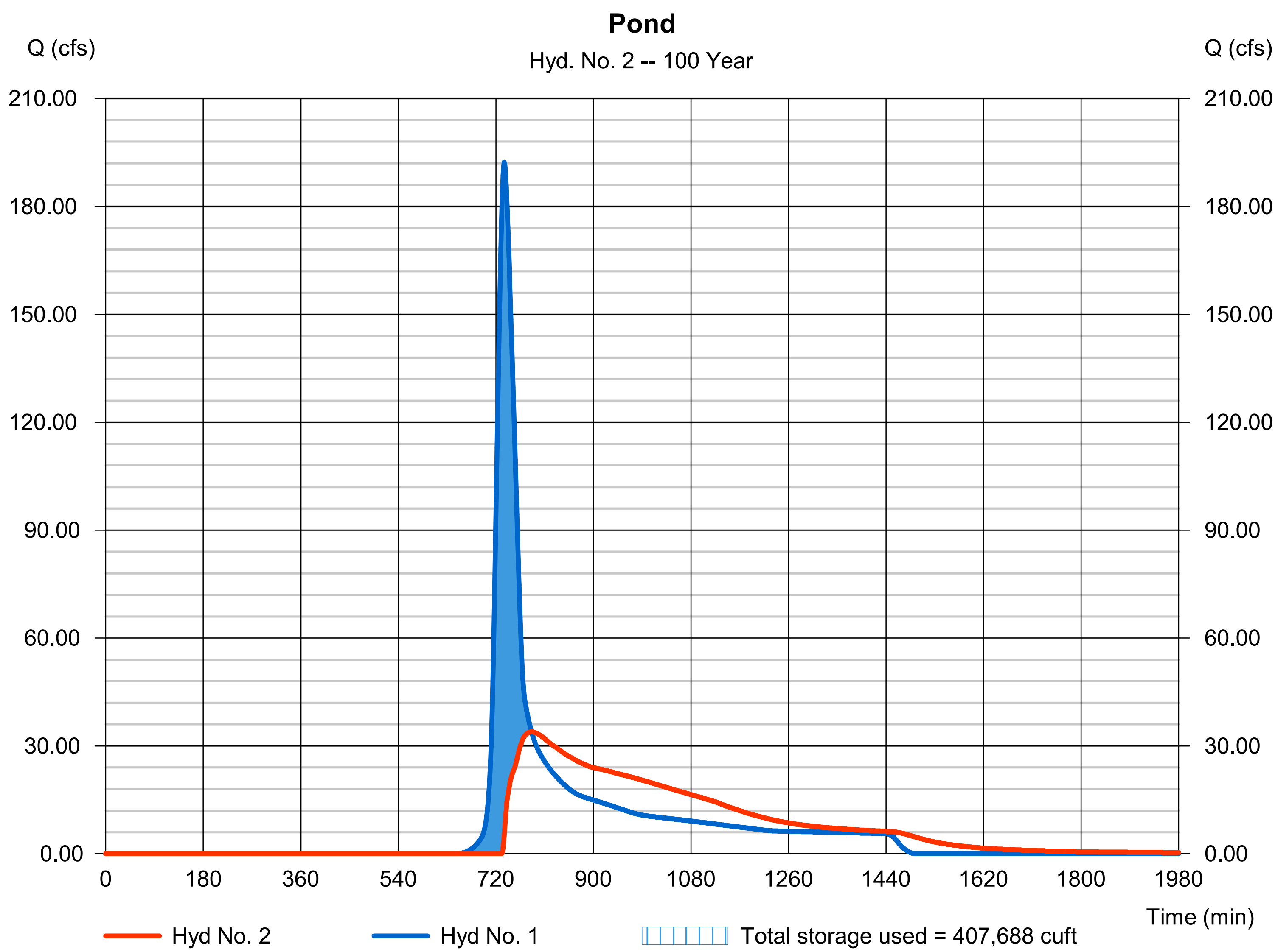
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 | Tuesday, 03 / 28 / 2017

Hyd. No. 2

Pond

Hydrograph type	= Reservoir	Peak discharge	= 33.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 786 min
Time interval	= 1 min	Hyd. volume	= 764,408 cuft
Inflow hyd. No.	= 1 - Area Above Hannah Ford leading to Culvert 1	Max. Elevation	= 42.76 ft
Reservoir name	= Pond Paired with Diversion	Max. Storage	= 407,688 cuft

Storage Indication method used.



Hydrograph Report

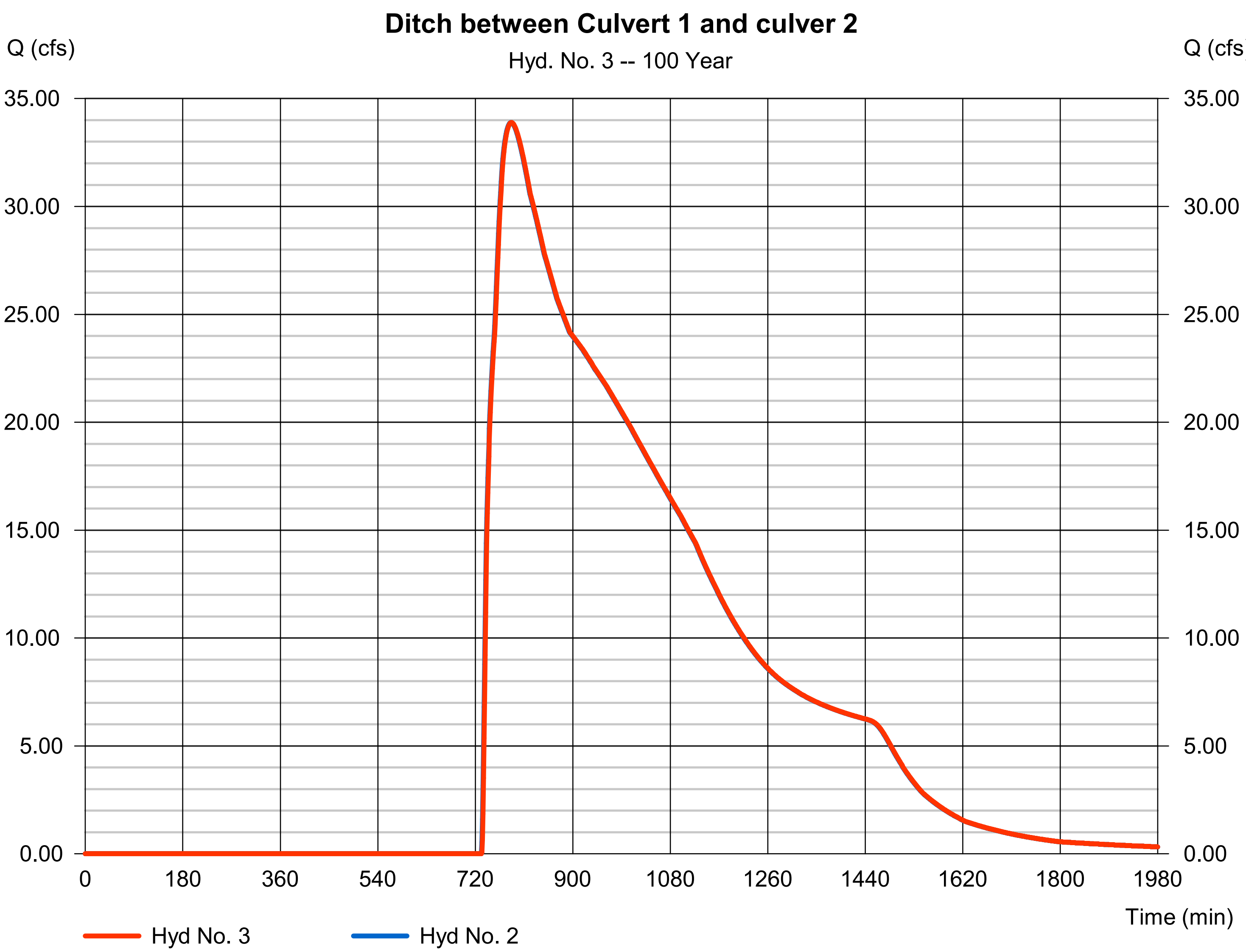
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 3

Ditch between Culvert 1 and culver 2

Hydrograph type	= Reach	Peak discharge	= 33.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 787 min
Time interval	= 1 min	Hyd. volume	= 764,404 cuft
Inflow hyd. No.	= 2 - Pond	Section type	= Trapezoidal
Reach length	= 118.0 ft	Channel slope	= 1.8 %
Manning's n	= 0.030	Bottom width	= 3.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 3.202	Rating curve m	= 1.279
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.2706

Modified Att-Kin routing method used.



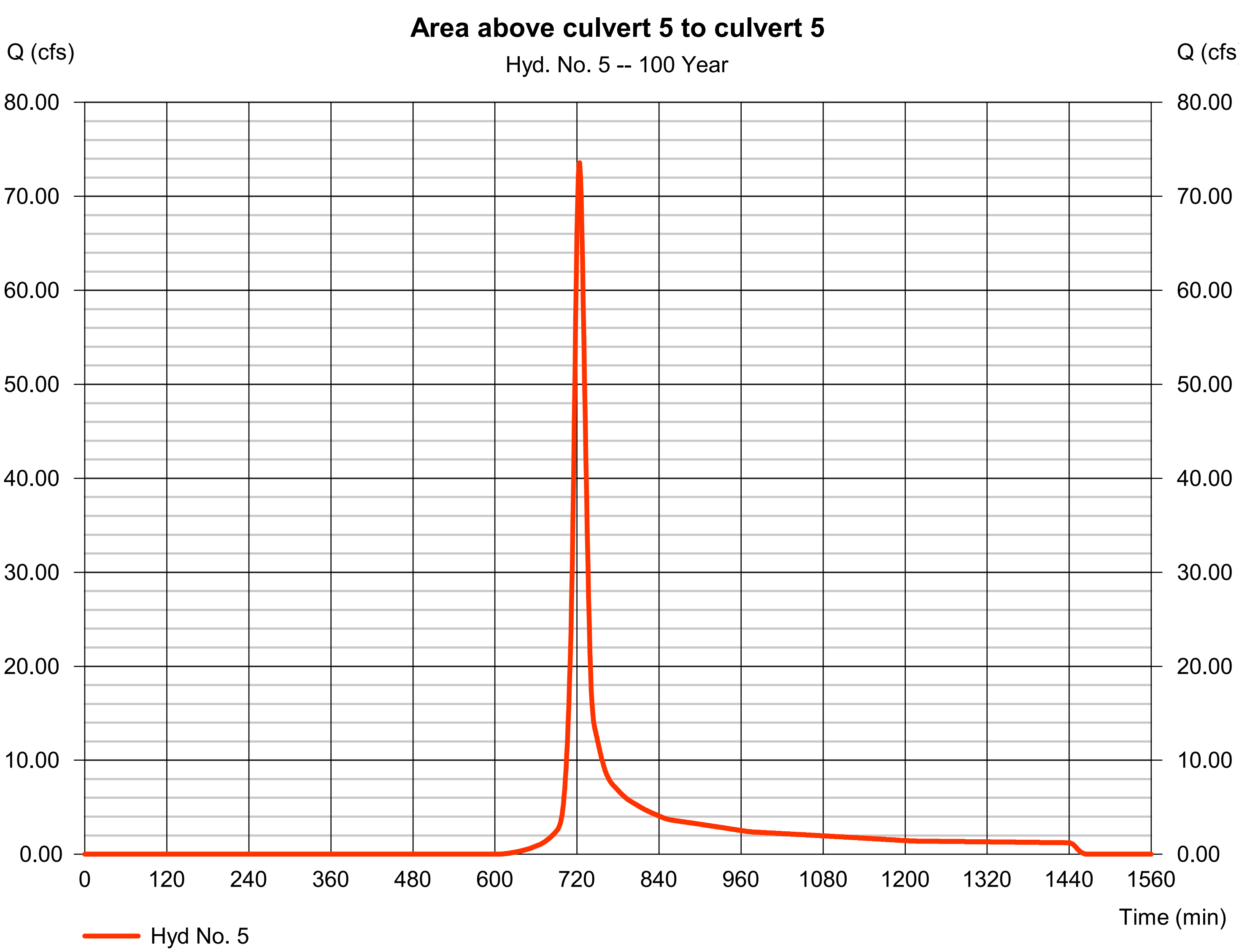
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 5

Area above culvert 5 to culvert 5

Hydrograph type	= SCS Runoff	Peak discharge	= 73.57 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 213,534 cuft
Drainage area	= 20.000 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.77 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

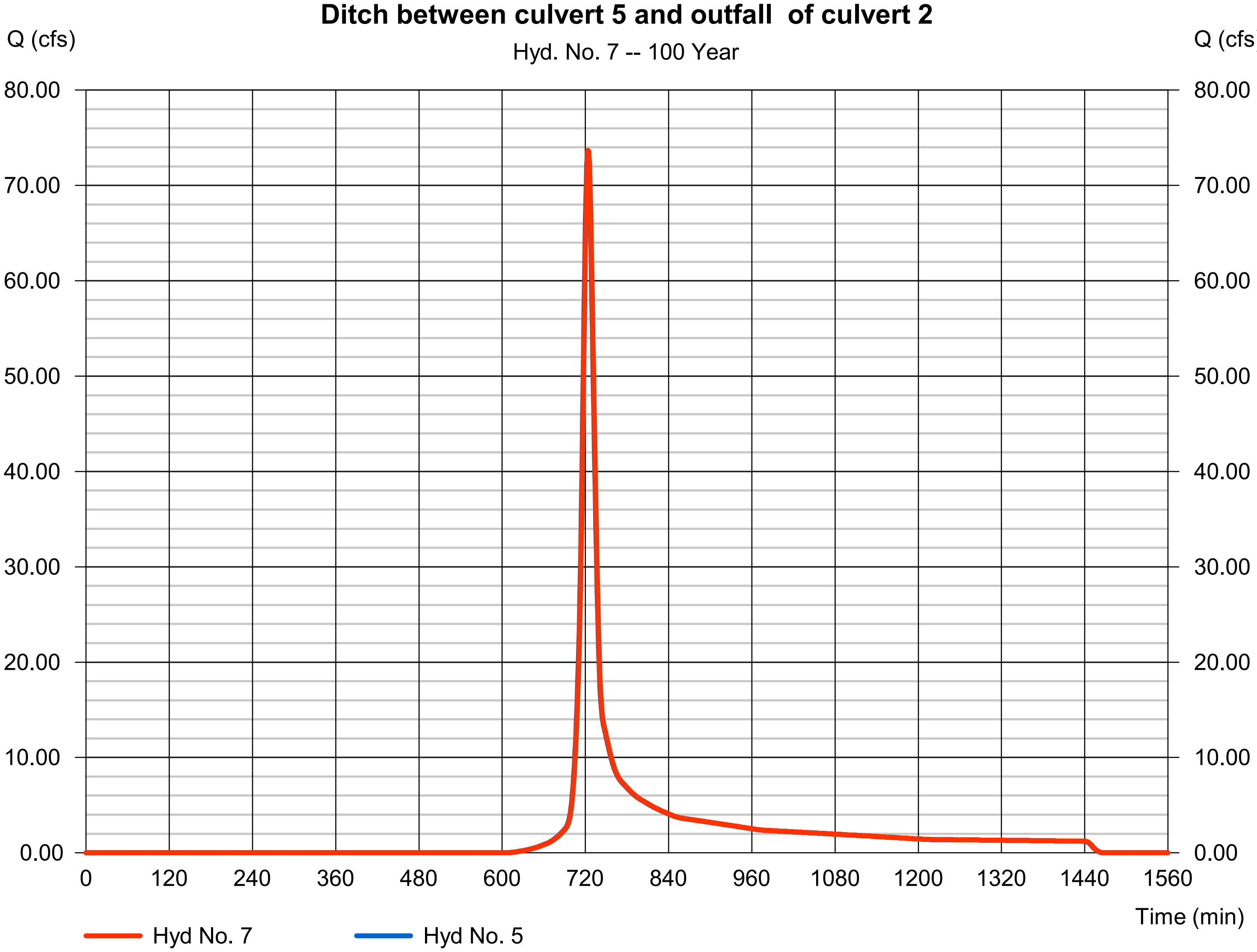
Hyd. No. 7

Ditch between culvert 5 and outfall of culvert 2

Hydrograph type	= Reach	Peak discharge	= 73.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 213,534 cuft
Inflow hyd. No.	= 5 - Area above culvert 5 to culvert 5	Section type	= Trapezoidal
Reach length	= 174.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.040	Bottom width	= 3.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 3.490	Rating curve m	= 1.249
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 1.1603

Modified Att-Kin routing method used.

Ditch between culvert 5 and outfall of culvert 2



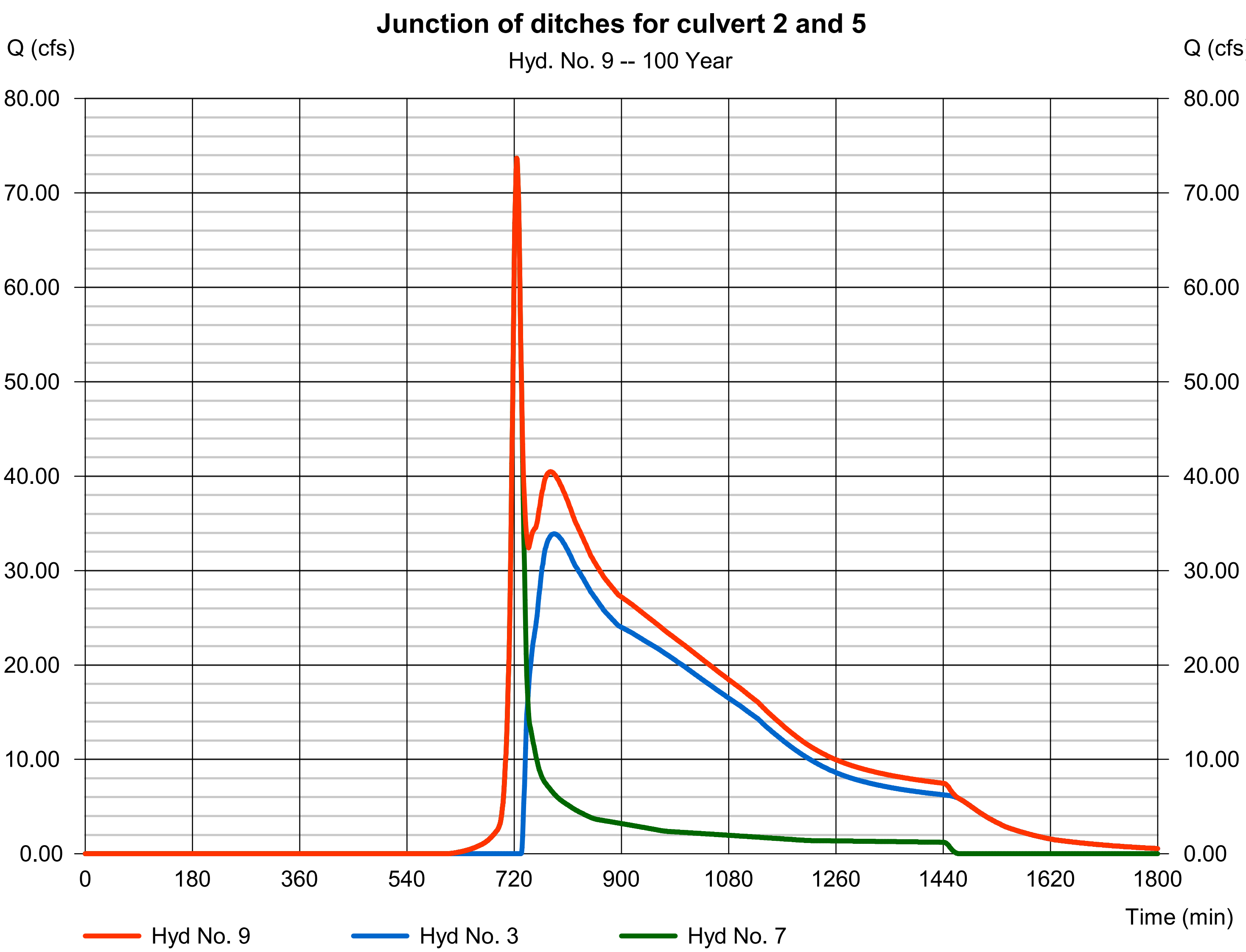
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 9

Junction of ditches for culvert 2 and 5

Hydrograph type	= Combine	Peak discharge	= 73.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 977,938 cuft
Inflow hyds.	= 3, 7	Contrib. drain. area	= 0.000 ac



Hydrograph Report

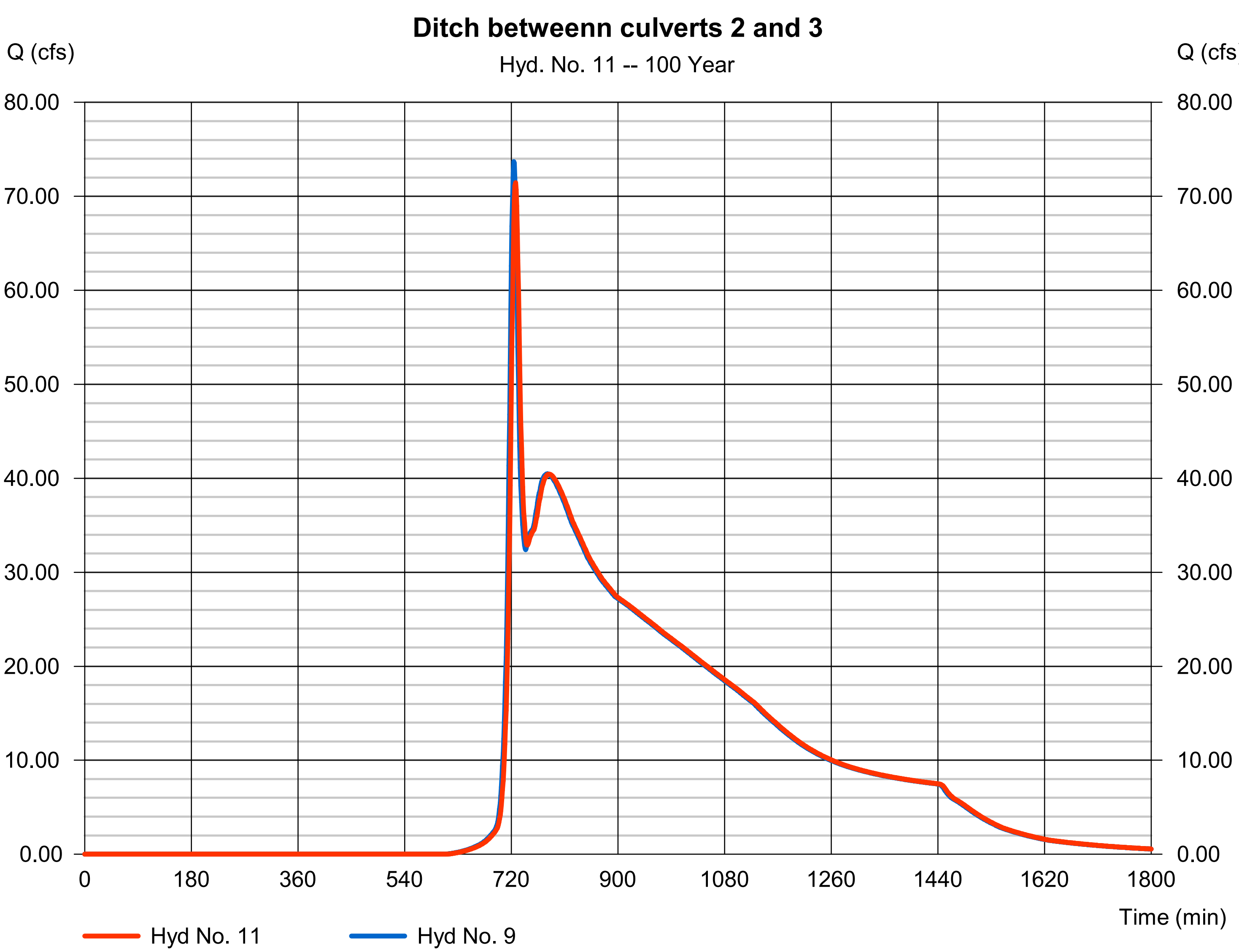
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 11

Ditch betweenn culverts 2 and 3

Hydrograph type	= Reach	Peak discharge	= 71.45 cfs
Storm frequency	= 100 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 977,931 cuft
Inflow hyd. No.	= 9 - Junction of ditches for culverts 2 and 5	Section type	= Trapezoidal
Reach length	= 815.0 ft	Channel slope	= 2.3 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 5.0 ft
Rating curve x	= 1.931	Rating curve m	= 1.341
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.3880

Modified Att-Kin routing method used.



Hydrograph Report

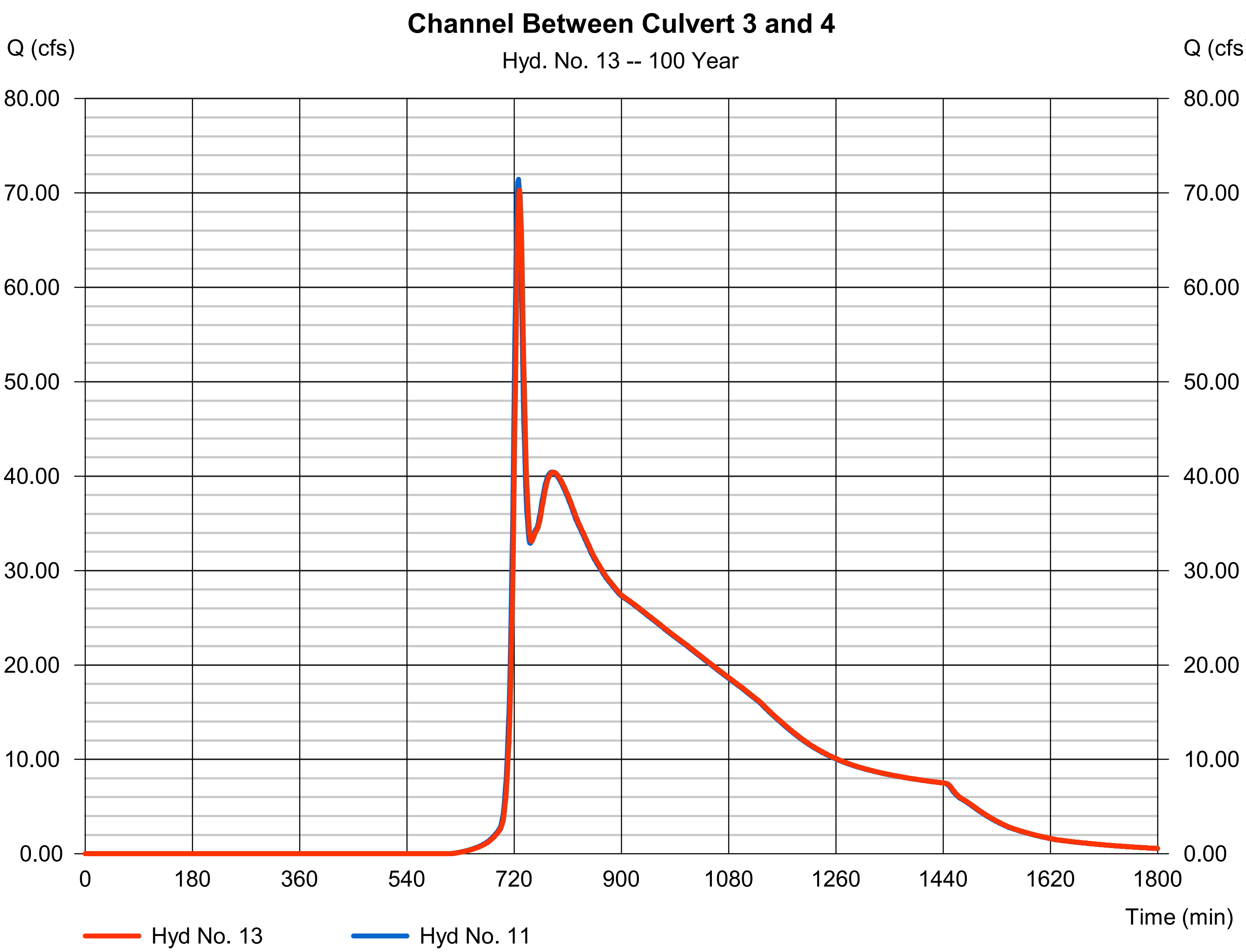
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 13

Channel Between Culvert 3 and 4

Hydrograph type	= Reach	Peak discharge	= 70.31 cfs
Storm frequency	= 100 yrs	Time to peak	= 729 min
Time interval	= 1 min	Hyd. volume	= 977,924 cuft
Inflow hyd. No.	= 11 - Ditch betweenn culverts 2 and 3	Section type	= Trapezoidal
Reach length	= 450.0 ft	Channel slope	= 1.2 %
Manning's n	= 0.040	Bottom width	= 5.0 ft
Side slope	= 3.0:1	Max. depth	= 3.0 ft
Rating curve x	= 1.395	Rating curve m	= 1.321
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.4843

Modified Att-Kin routing method used.



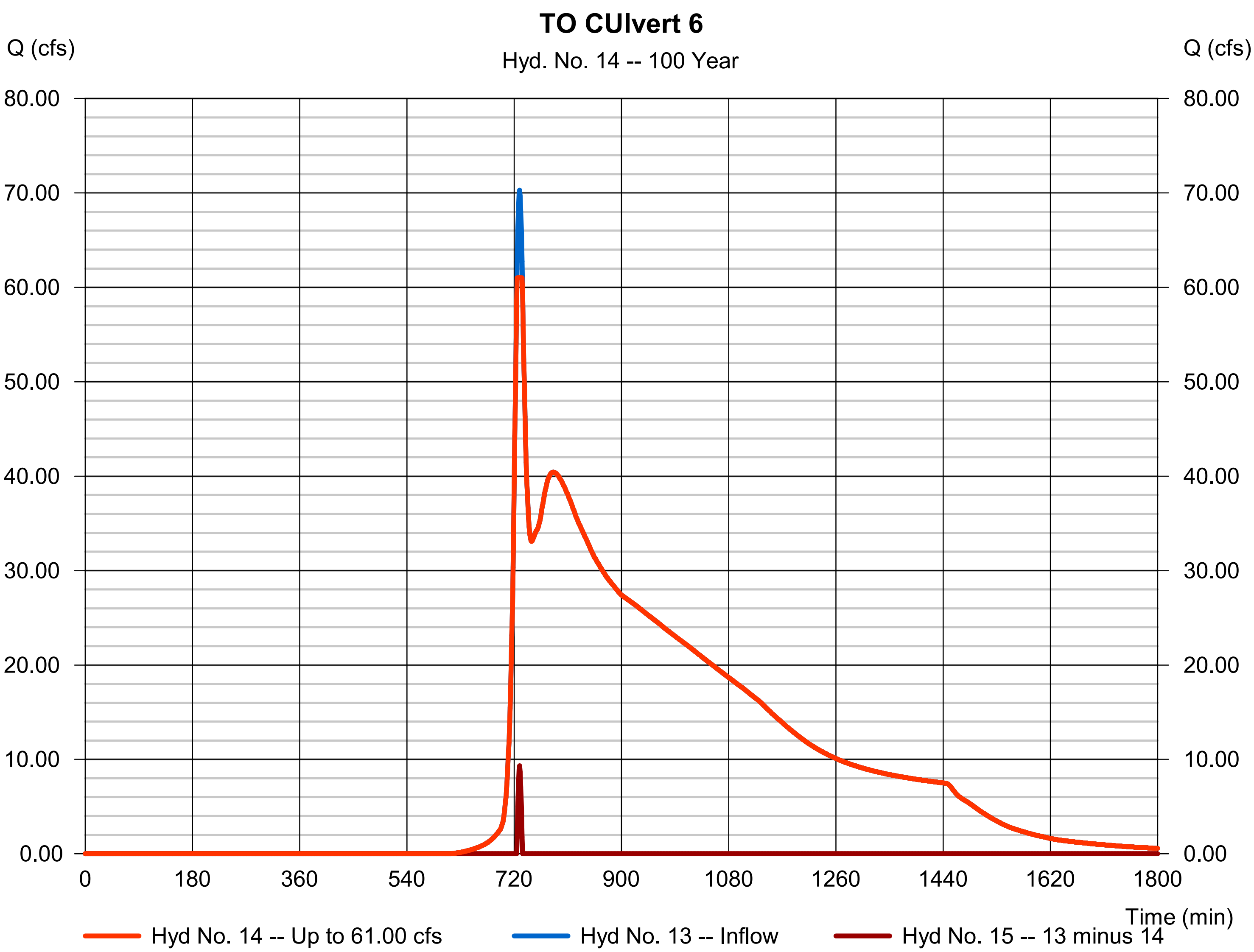
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 14

TO CUlvert 6

Hydrograph type	= Diversion1	Peak discharge	= 61.00 cfs
Storm frequency	= 100 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 974,637 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 15
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



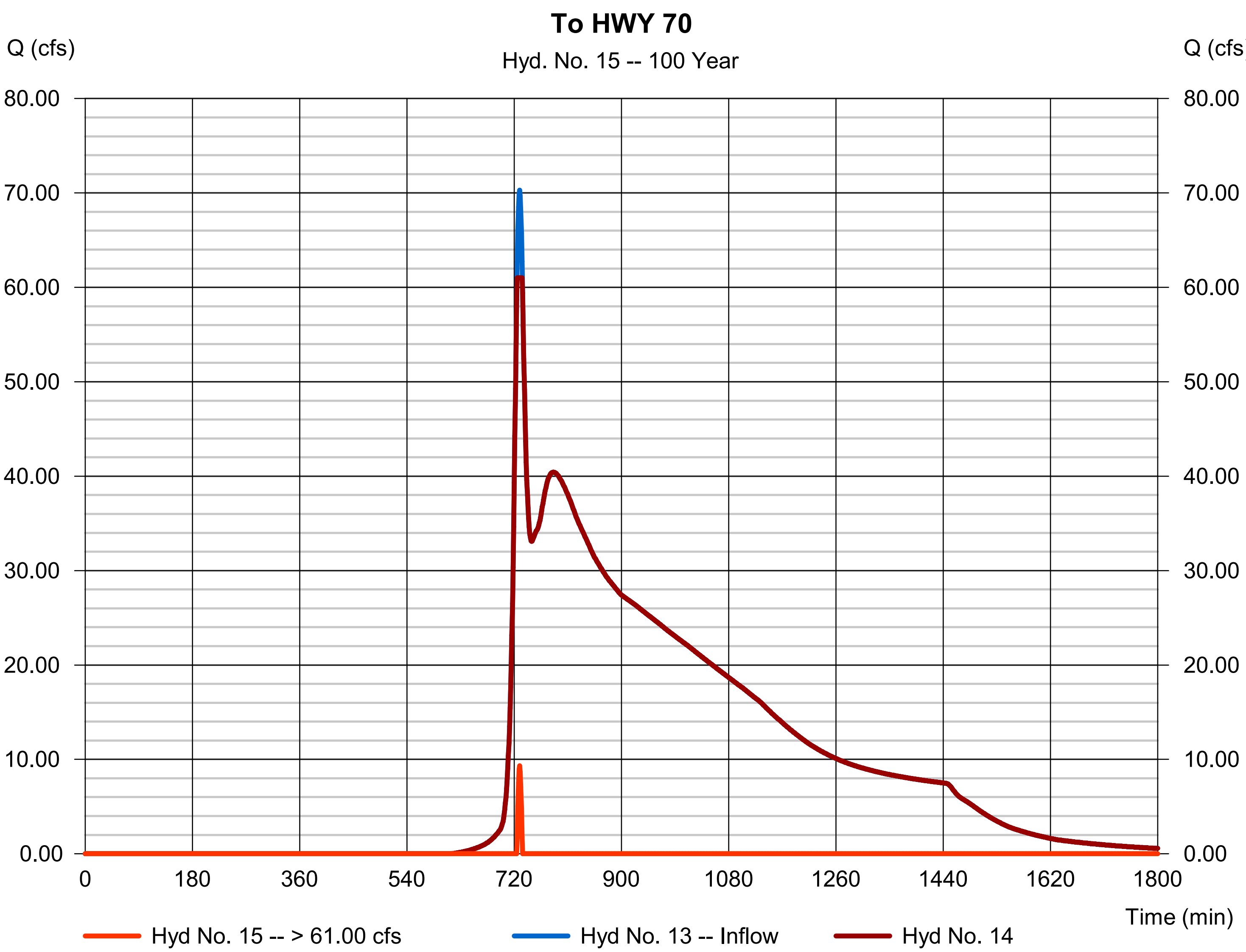
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 15

To HWY 70

Hydrograph type	= Diversion2	Peak discharge	= 9.307 cfs
Storm frequency	= 100 yrs	Time to peak	= 729 min
Time interval	= 1 min	Hyd. volume	= 3,287 cuft
Inflow hydrograph	= 13 - Channel Between Culvert 3 and 4	2nd diverted hyd.	= 14
Diversion method	= Constant Q	Constant Q	= 61.00 cfs



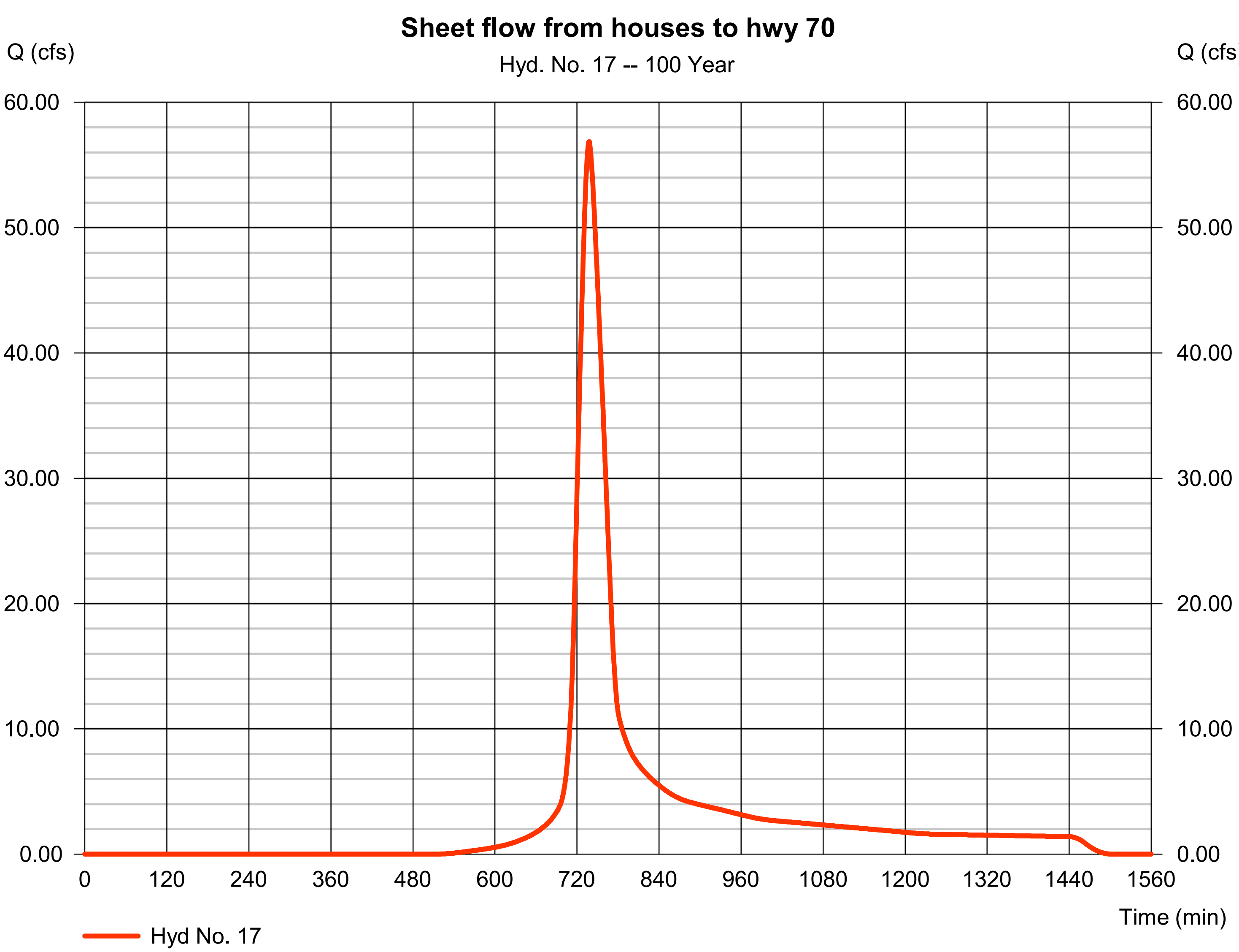
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 17

Sheet flow from houses to hwy 70

Hydrograph type	= SCS Runoff	Peak discharge	= 56.85 cfs
Storm frequency	= 100 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 276,957 cuft
Drainage area	= 20.330 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.63 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



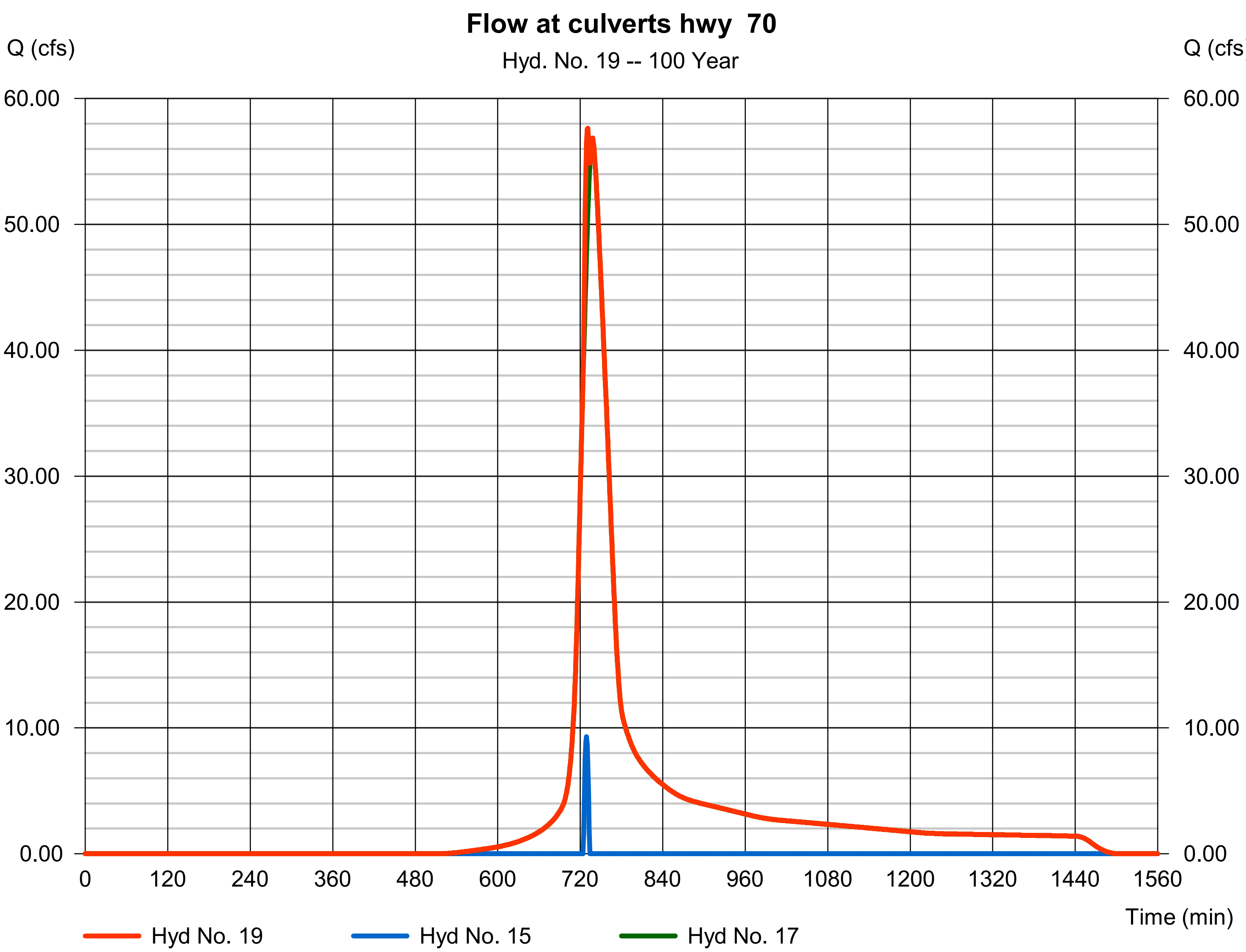
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 19

Flow at culverts hwy 70

Hydrograph type	= Combine	Peak discharge	= 57.64 cfs
Storm frequency	= 100 yrs	Time to peak	= 731 min
Time interval	= 1 min	Hyd. volume	= 280,027 cuft
Inflow hyds.	= 15, 17	Contrib. drain. area	= 20.330 ac



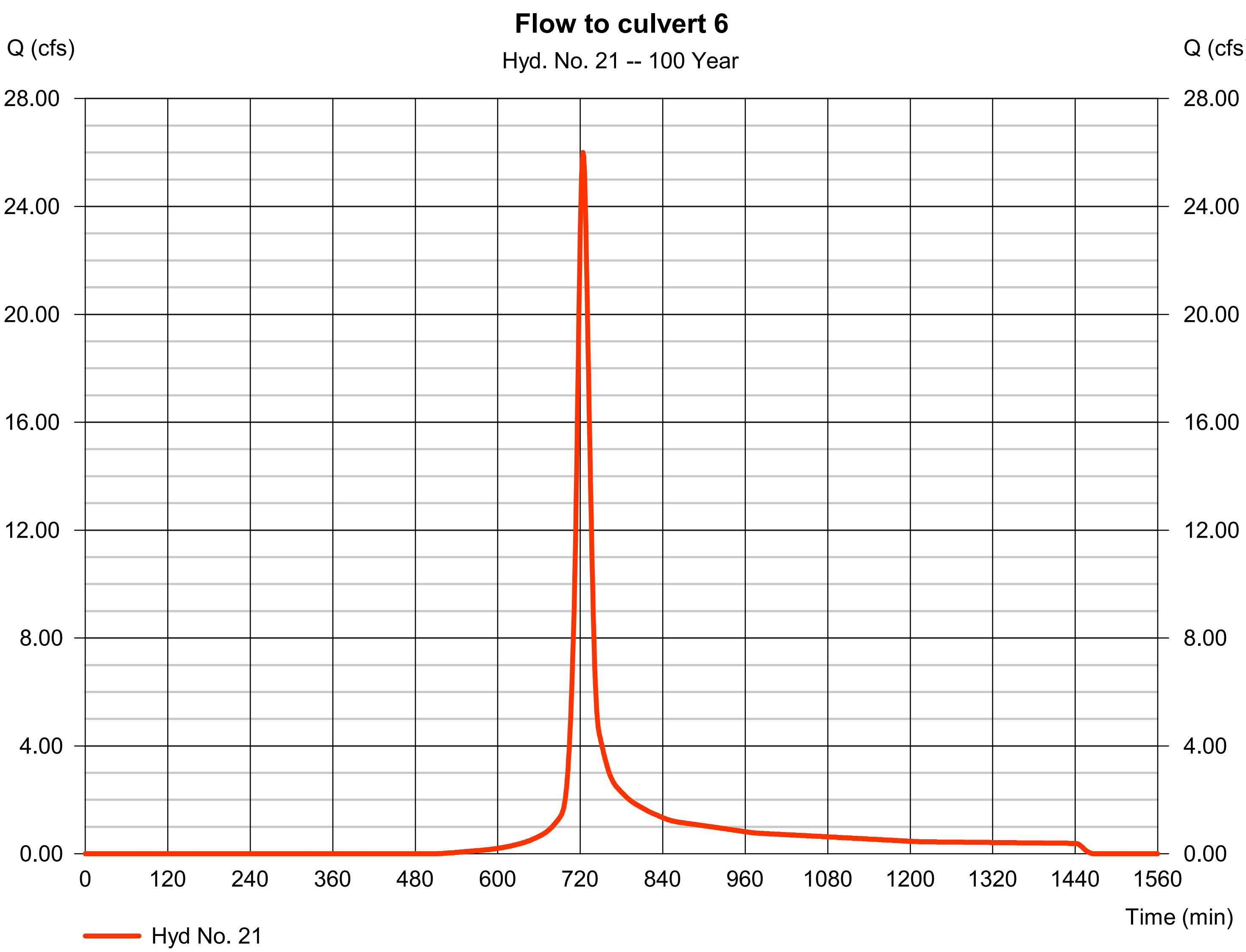
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 — Tuesday, 03 / 28 / 2017

Hyd. No. 21

Flow to culvert 6

Hydrograph type	= SCS Runoff	Peak discharge	= 26.00 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 77,038 cuft
Drainage area	= 5.720 ac	Curve number	= 68
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.80 min
Total precip.	= 7.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



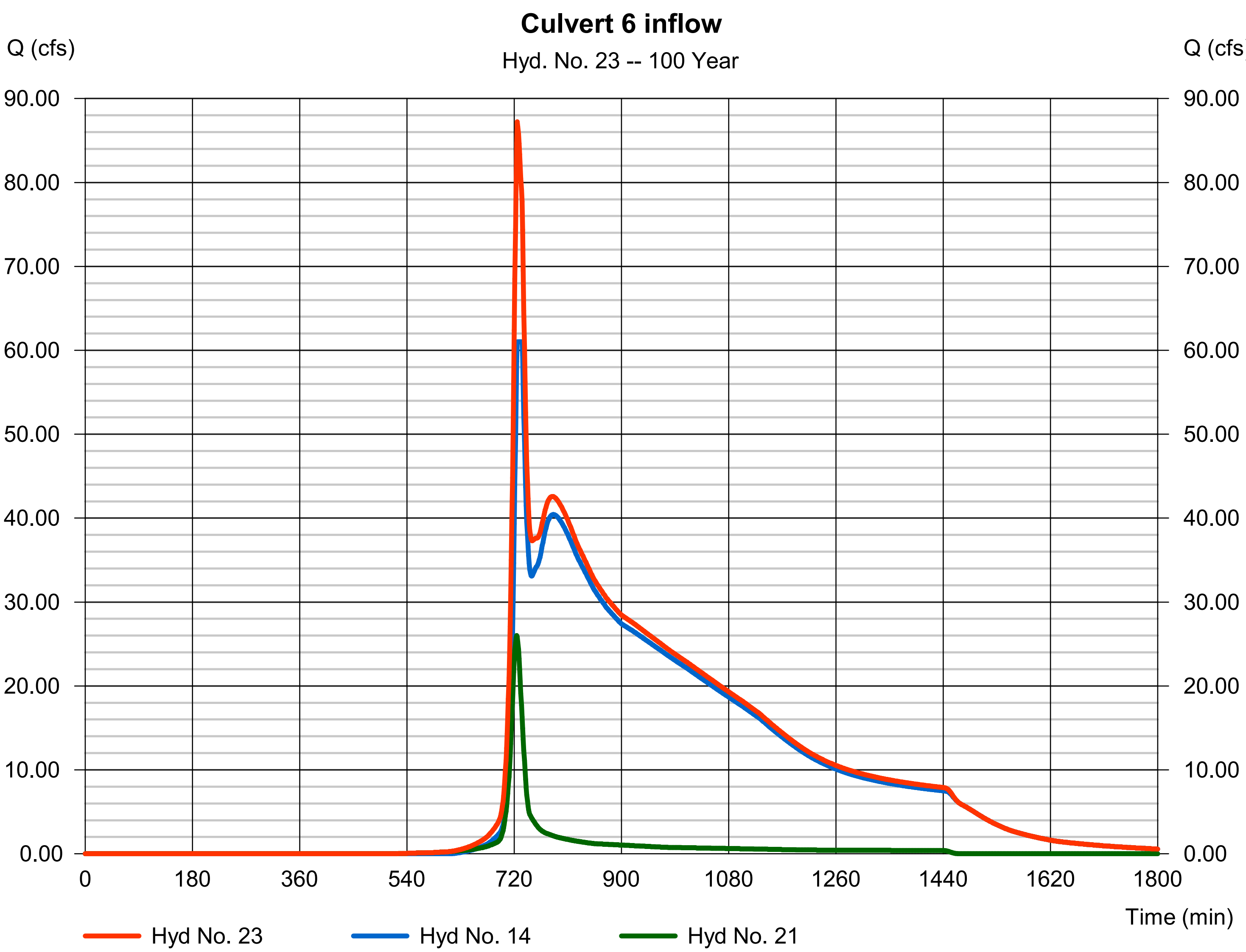
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v11 Tuesday, 03 / 28 / 2017

Hyd. No. 23

Culvert 6 inflow

Hydrograph type	= Combine	Peak discharge	= 87.24 cfs
Storm frequency	= 100 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 1,051,892 cuft
Inflow hyds.	= 14, 21	Contrib. drain. area	= 5.720 ac



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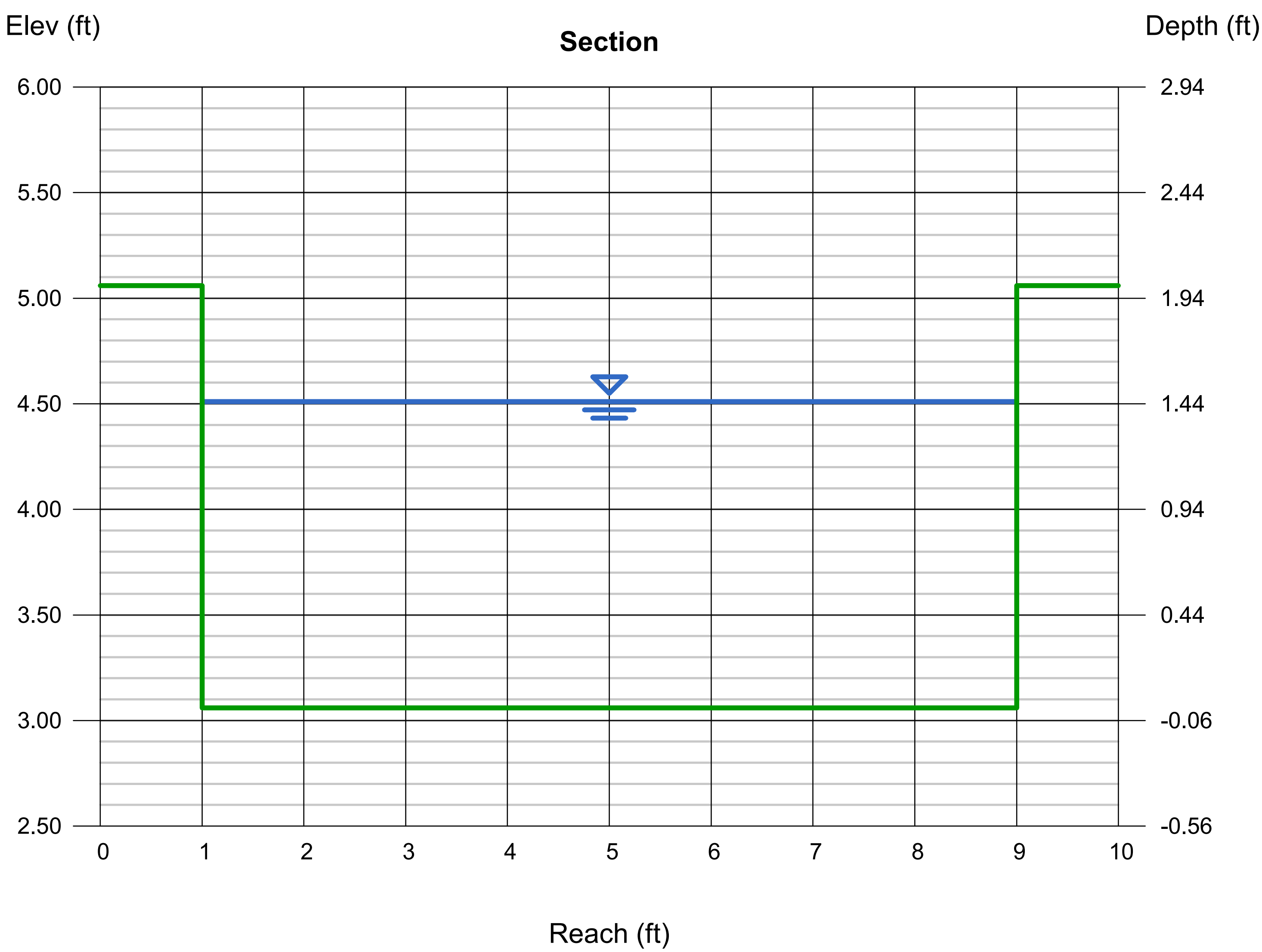
ENCLOSURE (C)

CULVERT / CHANNEL REPORTS

Channel Report

Concrete Diversion Ditch

Rectangular		**Highlighted**	
Bottom Width (ft)	= 8.00	Depth (ft)	= 1.45
Total Depth (ft)	= 2.00	Q (cfs)	= 75.00
		Area (sqft)	= 11.60
Invert Elev (ft)	= 3.06	Velocity (ft/s)	= 6.47
Slope (%)	= 0.40	Wetted Perim (ft)	= 10.90
N-Value	= 0.015	Crit Depth, Yc (ft)	= 1.40
		Top Width (ft)	= 8.00
Calculations		EGL (ft)	= 2.10
Compute by:	Known Q		
Known Q (cfs)	= 75.00		



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Monday, Mar 6 2017

Culvert 1 50yr

Invert Elev Dn (ft)	=	30.42
Pipe Length (ft)	=	22.01
Slope (%)	=	0.00
Invert Elev Up (ft)	=	30.42
Rise (in)	=	36.0
Shape	=	Elliptical
Span (in)	=	60.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

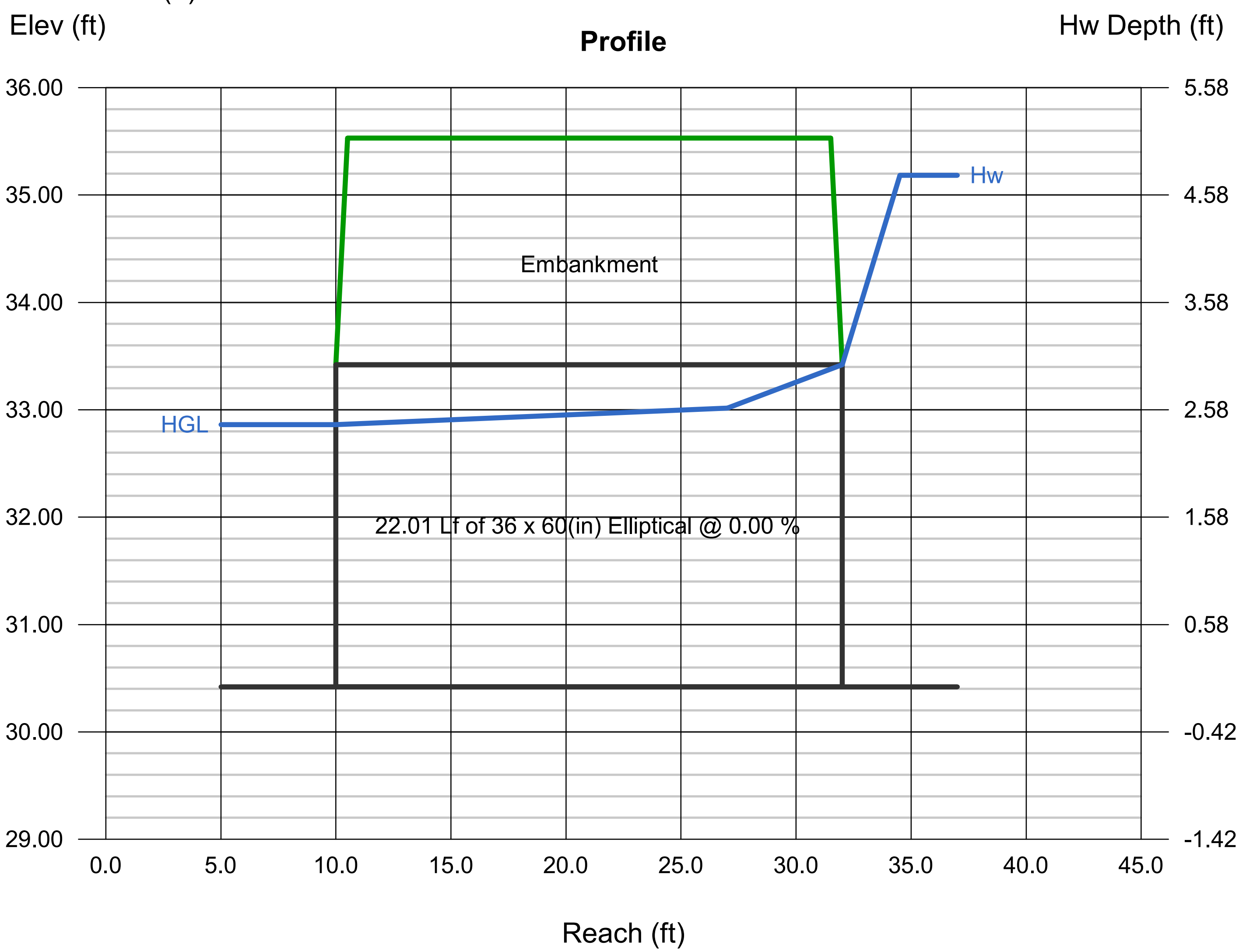
Top Elevation (ft)	=	35.53
Top Width (ft)	=	21.00
Crest Width (ft)	=	300.00

Calculations

Qmin (cfs)	=	98.00
Qmax (cfs)	=	150.27
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	98.00
Qpipe (cfs)	=	98.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.19
Veloc Up (ft/s)	=	8.90
HGL Dn (ft)	=	32.86
HGL Up (ft)	=	33.06
Hw Elev (ft)	=	35.18
Hw/D (ft)	=	1.59
Flow Regime	=	Inlet Control



Culvert Report

Culvert 1 50yr with Pond

Invert Elev Dn (ft)	=	30.42
Pipe Length (ft)	=	22.01
Slope (%)	=	0.00
Invert Elev Up (ft)	=	30.42
Rise (in)	=	36.0
Shape	=	Elliptical
Span (in)	=	60.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

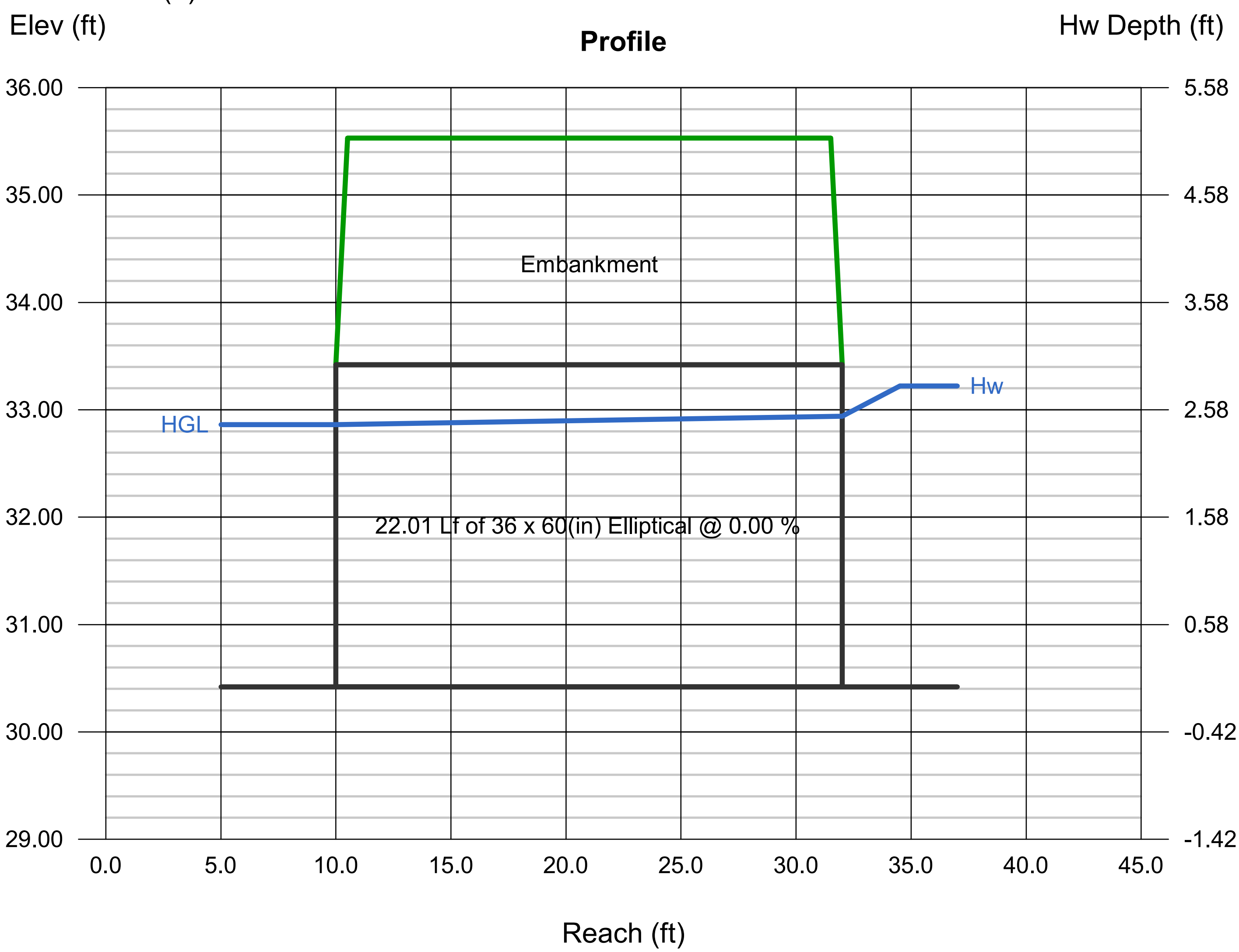
Top Elevation (ft)	=	35.53
Top Width (ft)	=	21.00
Crest Width (ft)	=	300.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	37.95
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	37.00
Qpipe (cfs)	=	37.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.47
Veloc Up (ft/s)	=	3.47
HGL Dn (ft)	=	32.86
HGL Up (ft)	=	32.94
Hw Elev (ft)	=	33.22
Hw/D (ft)	=	0.93
Flow Regime	=	Outlet Control



Culvert Report

Culvert 2 50 yr Existing Conditions

Invert Elev Dn (ft)	= 26.98
Pipe Length (ft)	= 30.83
Slope (%)	= 4.35
Invert Elev Up (ft)	= 28.32
Rise (in)	= 36.0
Shape	= Circular
Span (in)	= 36.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

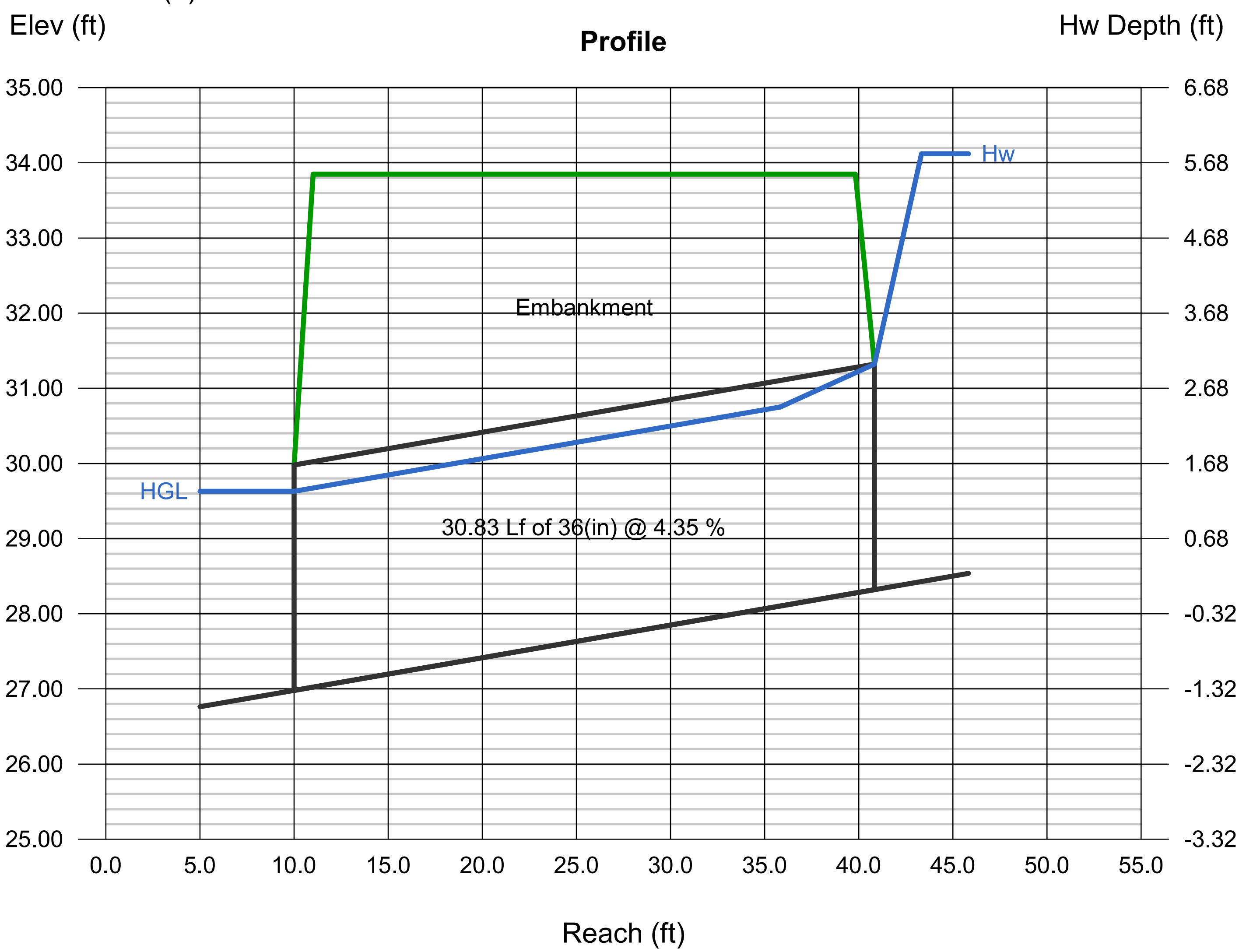
Top Elevation (ft)	= 33.85
Top Width (ft)	= 28.80
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 13.00
Qmax (cfs)	= 112.00
Tailwater Elev (ft)	= Normal

Highlighted

Qtotal (cfs)	= 112.00
Qpipe (cfs)	= 69.57
Qovertop (cfs)	= 42.43
Veloc Dn (ft/s)	= 10.53
Veloc Up (ft/s)	= 10.53
HGL Dn (ft)	= 29.63
HGL Up (ft)	= 30.97
Hw Elev (ft)	= 34.12
Hw/D (ft)	= 1.93
Flow Regime	= Inlet Control



Culvert Report

Culvert 2 100 yr Existing Conditions

Invert Elev Dn (ft)	=	26.98
Pipe Length (ft)	=	30.83
Slope (%)	=	4.35
Invert Elev Up (ft)	=	28.32
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

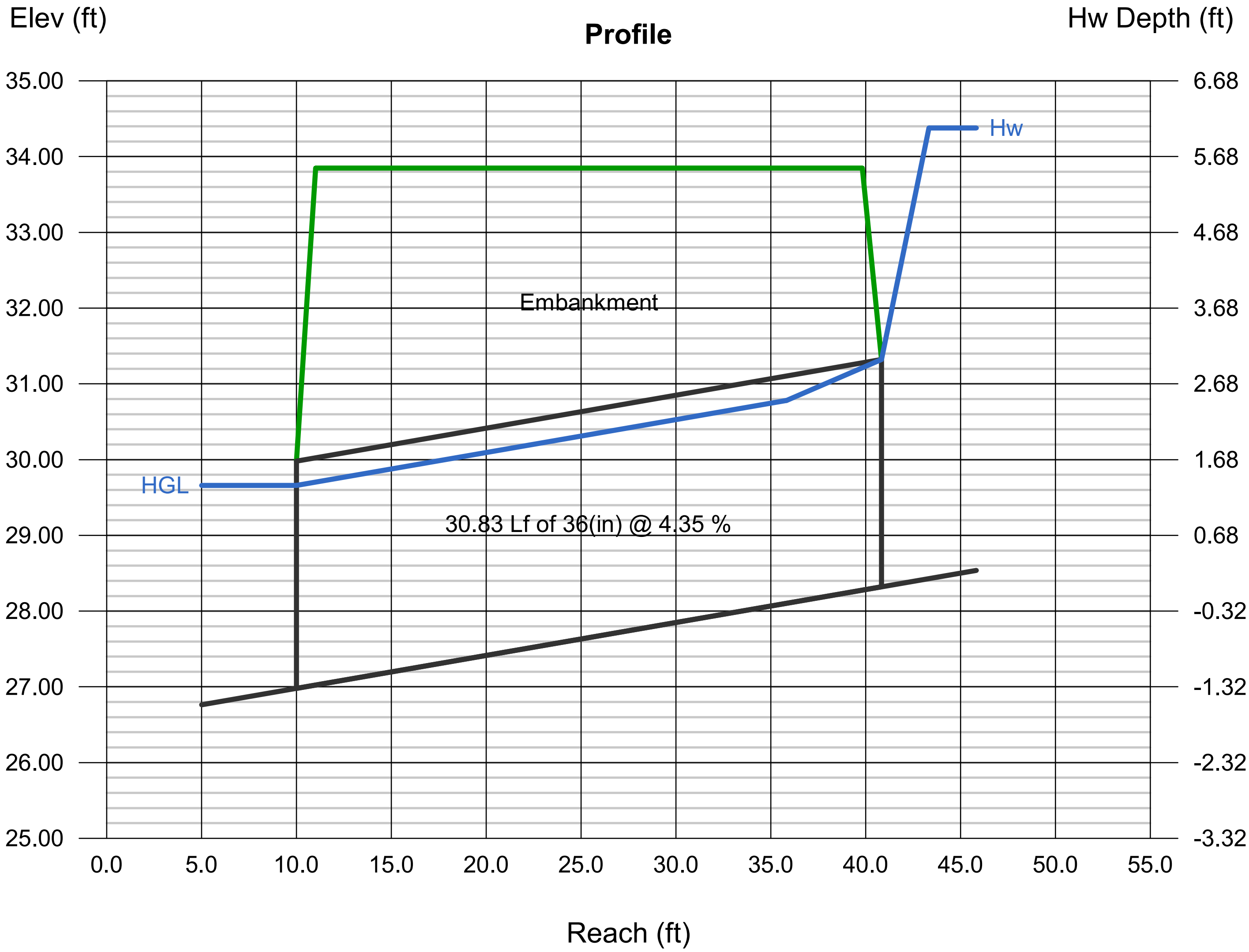
Top Elevation (ft)	=	33.85
Top Width (ft)	=	28.80
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	150.00
Qmax (cfs)	=	192.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	192.00
Qpipe (cfs)	=	71.85
Qovertop (cfs)	=	120.15
Veloc Dn (ft/s)	=	10.78
Veloc Up (ft/s)	=	10.78
HGL Dn (ft)	=	29.66
HGL Up (ft)	=	31.00
Hw Elev (ft)	=	34.38
Hw/D (ft)	=	2.02
Flow Regime	=	Inlet Control



Culvert Report

Culvert 2 50 yr with Diversion and Pond

Invert Elev Dn (ft)	=	26.98
Pipe Length (ft)	=	30.83
Slope (%)	=	4.35
Invert Elev Up (ft)	=	28.32
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

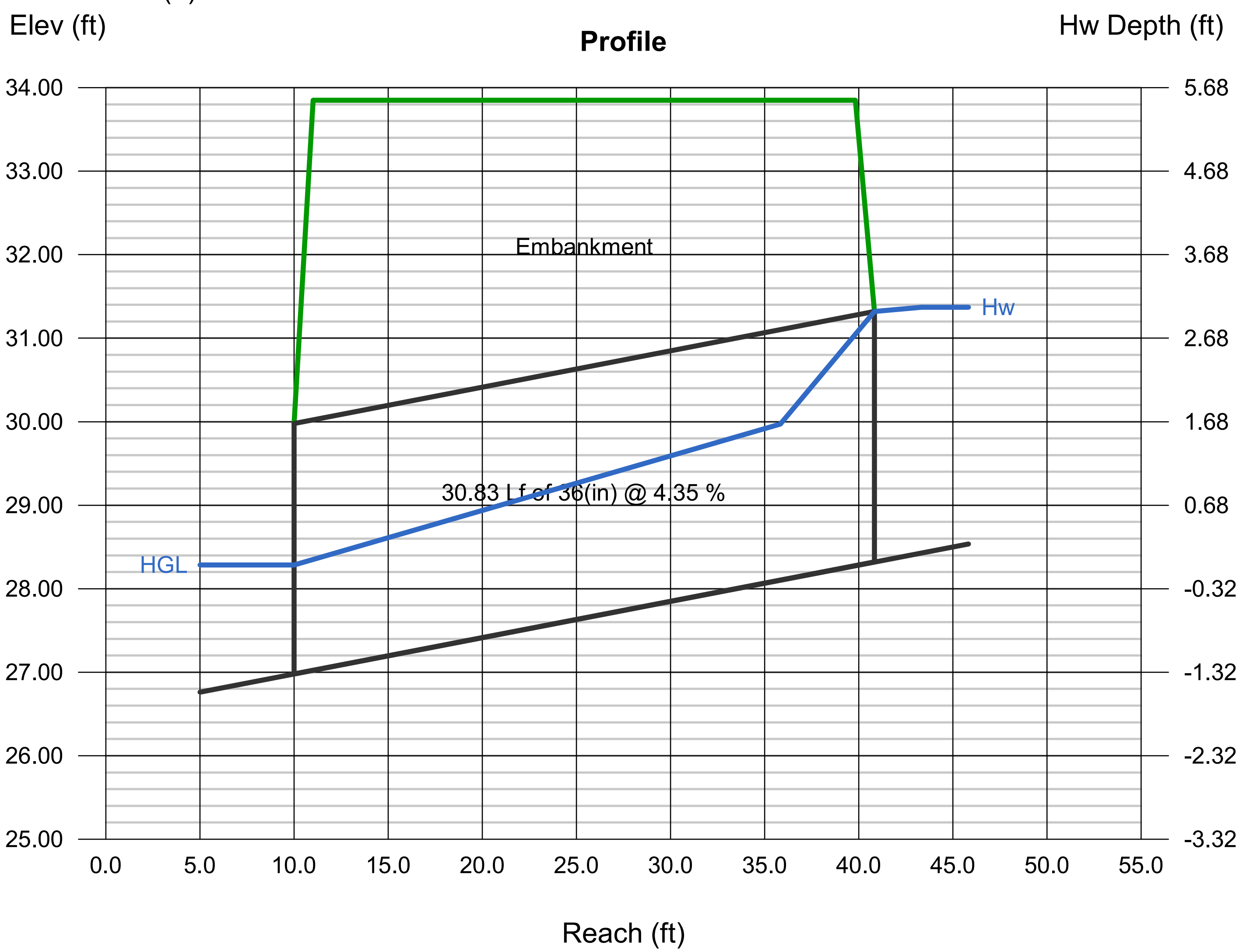
Top Elevation (ft)	=	33.85
Top Width (ft)	=	28.80
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	13.00
Qmax (cfs)	=	37.95
Tailwater Elev (ft)	=	Normal

Highlighted

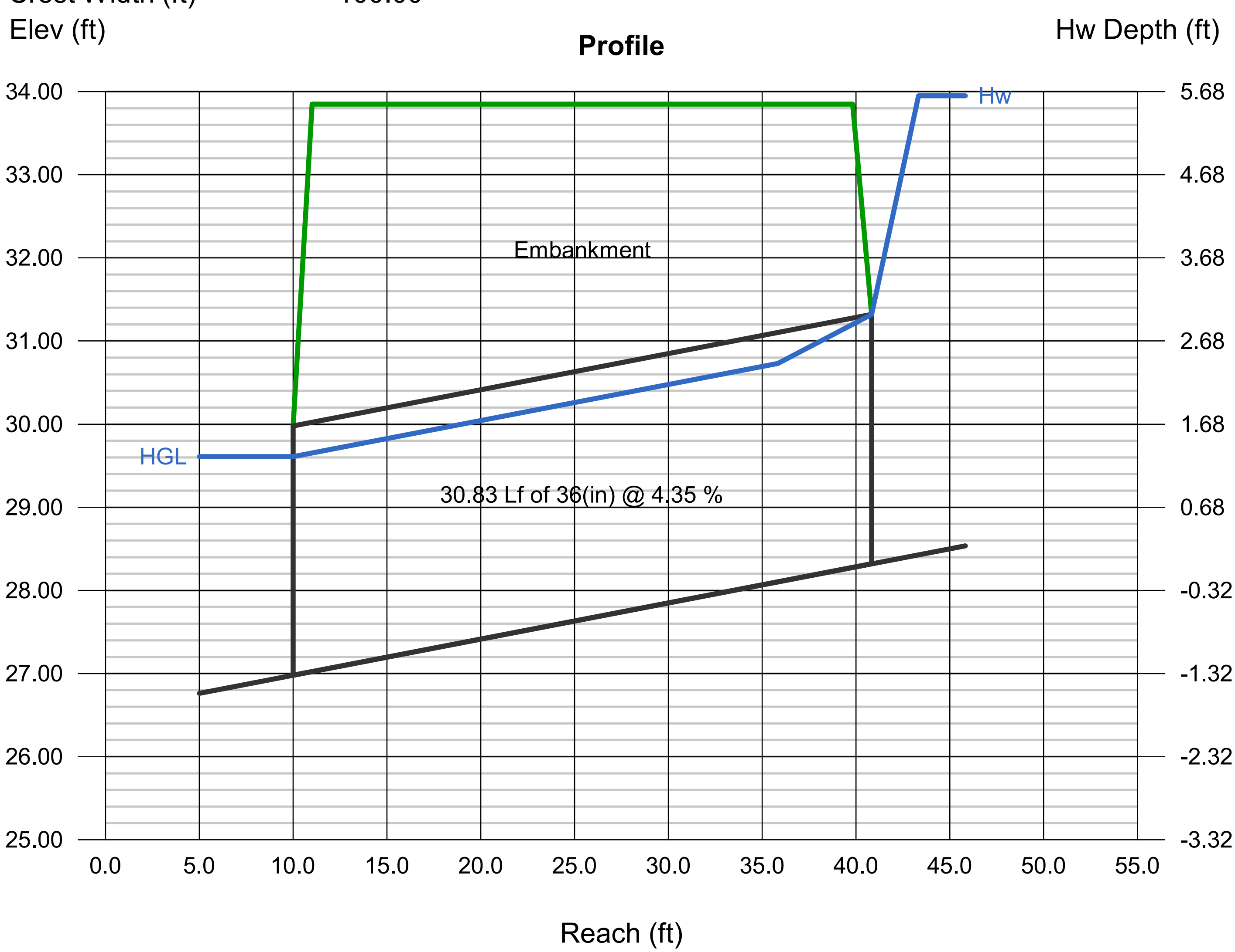
Qtotal (cfs)	=	37.00
Qpipe (cfs)	=	37.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	12.55
Veloc Up (ft/s)	=	7.49
HGL Dn (ft)	=	28.28
HGL Up (ft)	=	30.30
Hw Elev (ft)	=	31.37
Hw/D (ft)	=	1.02
Flow Regime	=	Inlet Control



Culvert Report

Culvert 2 100 yr with Diversion and Pond

Invert Elev Dn (ft)	= 26.98	**Calculations**	
Pipe Length (ft)	= 30.83	Qmin (cfs)	= 30.00
Slope (%)	= 4.35	Qmax (cfs)	= 77.00
Invert Elev Up (ft)	= 28.32	Tailwater Elev (ft)	= Normal
Rise (in)	= 36.0		
Shape	= Circular	**Highlighted**	
Span (in)	= 36.0	Qtotal (cfs)	= 77.00
No. Barrels	= 1	Qpipe (cfs)	= 68.02
n-Value	= 0.013	Qovertop (cfs)	= 8.98
Culvert Type	= Circular Concrete	Veloc Dn (ft/s)	= 10.36
Culvert Entrance	= Square edge w/headwall (C)	Veloc Up (ft/s)	= 10.36
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5	HGL Dn (ft)	= 29.61
		HGL Up (ft)	= 30.95
Embankment		Hw Elev (ft)	= 33.95
Top Elevation (ft)	= 33.85	Hw/D (ft)	= 1.88
Top Width (ft)	= 28.80	Flow Regime	= Inlet Control
Crest Width (ft)	= 100.00		



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Feb 13 2017

Culvert 3 50yr Existing Conditions

Invert Elev Dn (ft)	=	7.57
Pipe Length (ft)	=	33.24
Slope (%)	=	2.17
Invert Elev Up (ft)	=	8.29
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

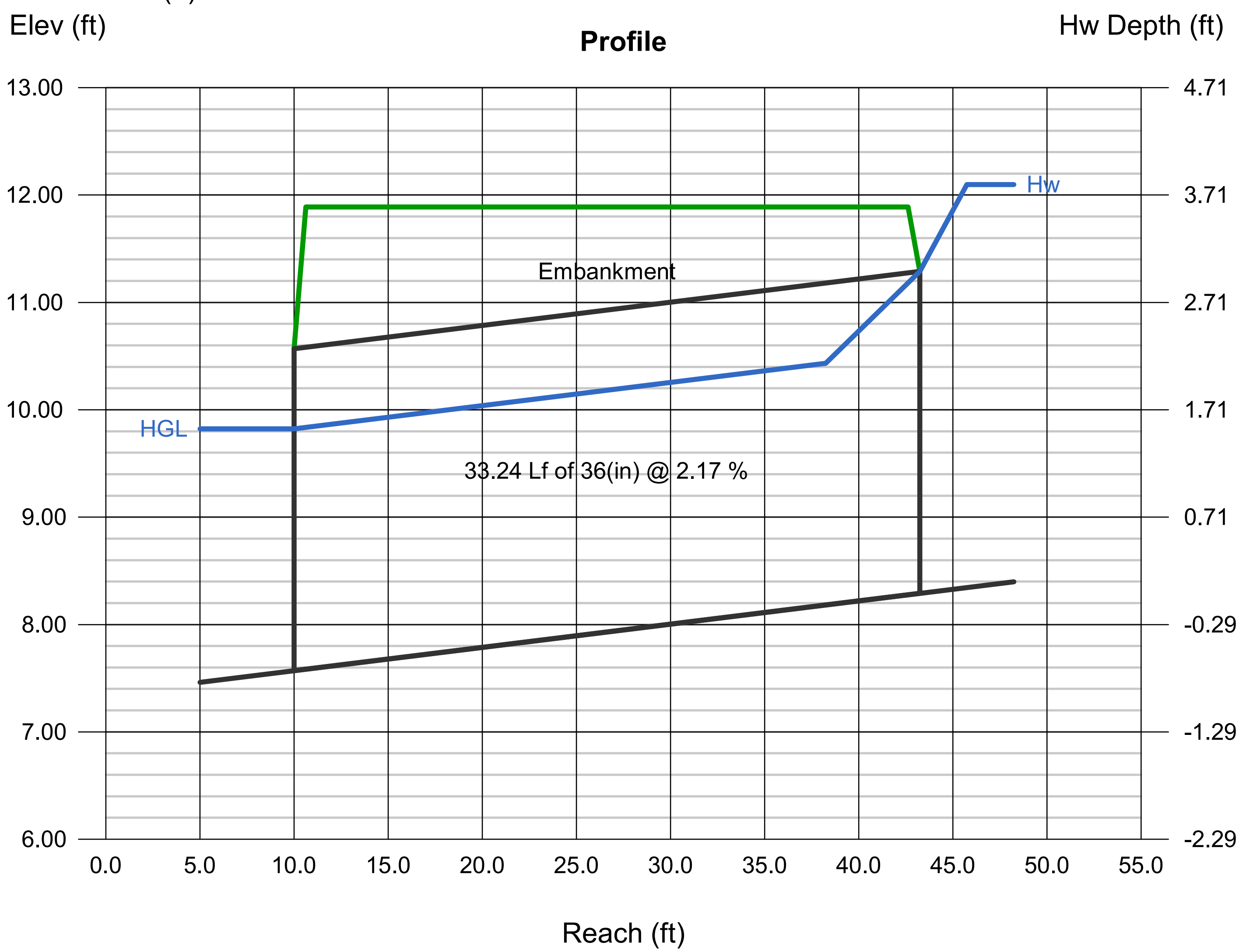
Top Elevation (ft)	=	11.89
Top Width (ft)	=	32.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	82.00
Qmax (cfs)	=	181.23
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	172.00
Qpipe (cfs)	=	143.82
Qovertop (cfs)	=	28.18
Veloc Dn (ft/s)	=	8.42
Veloc Up (ft/s)	=	8.42
HGL Dn (ft)	=	9.82
HGL Up (ft)	=	10.54
Hw Elev (ft)	=	12.10
Hw/D (ft)	=	1.27
Flow Regime	=	Inlet Control



Culvert Report

Culvert 3 100yr Existing Conditions

Invert Elev Dn (ft)	=	7.57
Pipe Length (ft)	=	33.24
Slope (%)	=	2.17
Invert Elev Up (ft)	=	8.29
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

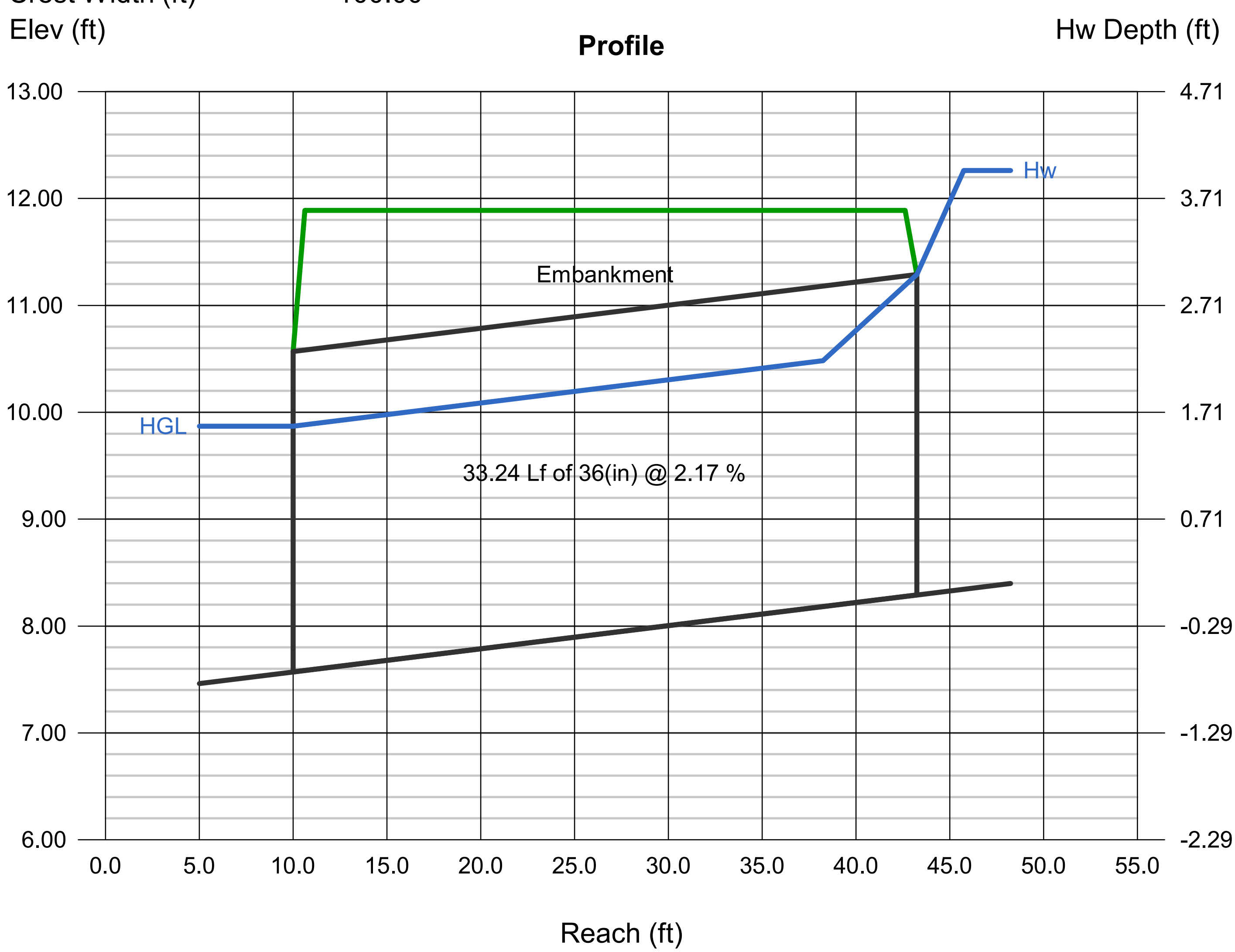
Top Elevation (ft)	=	11.89
Top Width (ft)	=	32.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	82.00
Qmax (cfs)	=	230.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	222.00
Qpipe (cfs)	=	150.17
Qovertop (cfs)	=	71.83
Veloc Dn (ft/s)	=	8.60
Veloc Up (ft/s)	=	8.60
HGL Dn (ft)	=	9.87
HGL Up (ft)	=	10.59
Hw Elev (ft)	=	12.26
Hw/D (ft)	=	1.32
Flow Regime	=	Inlet Control



Culvert Report

Culvert 3 50yr With Diversion and Pond

Invert Elev Dn (ft)	= 7.57
Pipe Length (ft)	= 33.24
Slope (%)	= 2.17
Invert Elev Up (ft)	= 8.29
Rise (in)	= 36.0
Shape	= Circular
Span (in)	= 36.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

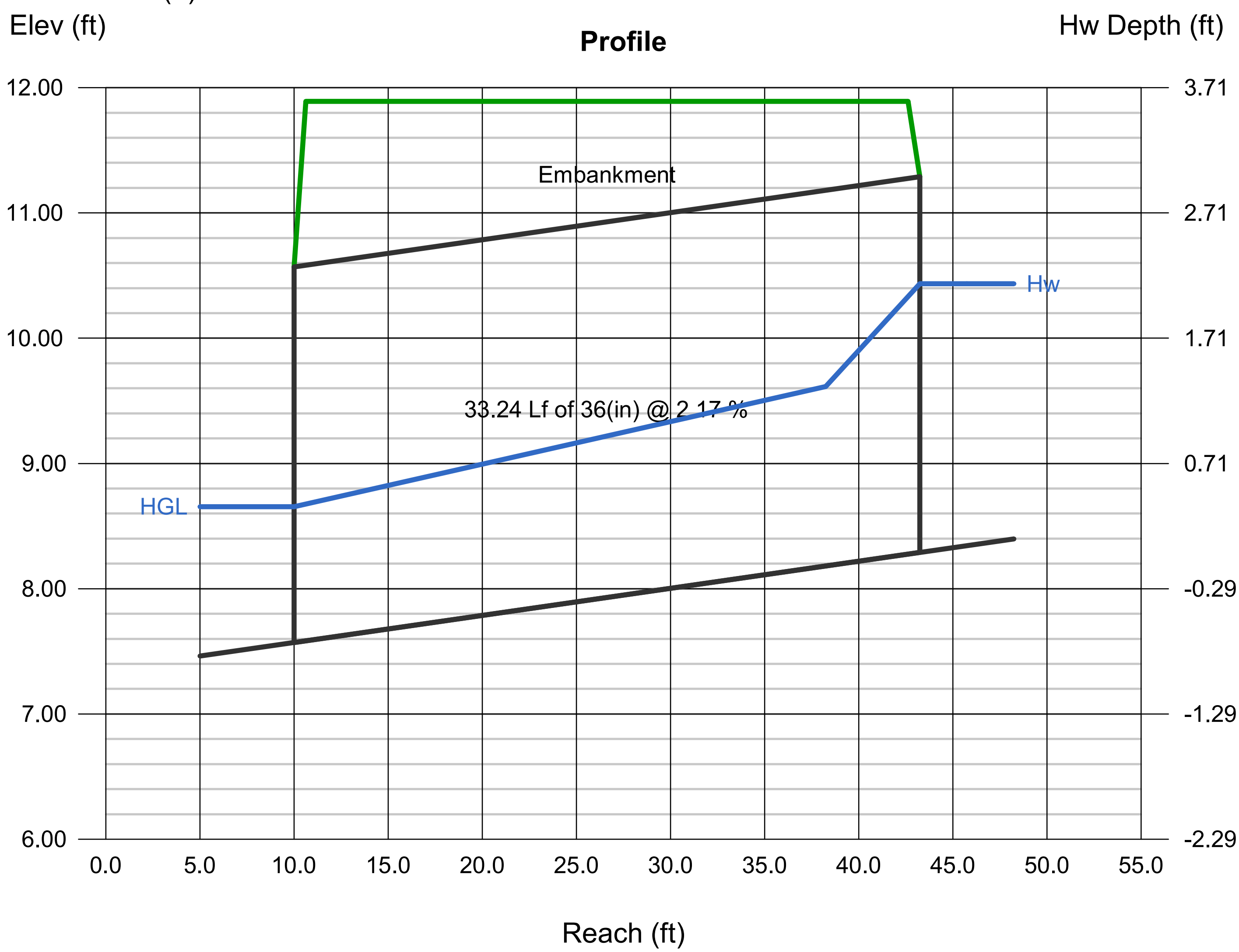
Top Elevation (ft)	= 11.89
Top Width (ft)	= 32.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 20.00
Qmax (cfs)	= 65.83
Tailwater Elev (ft)	= Normal

Highlighted

Qtotal (cfs)	= 65.00
Qpipe (cfs)	= 65.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 9.41
Veloc Up (ft/s)	= 6.16
HGL Dn (ft)	= 8.65
HGL Up (ft)	= 9.79
Hw Elev (ft)	= 10.43
Hw/D (ft)	= 0.71
Flow Regime	= Inlet Control



Culvert Report

Culvert 3 100yr With Diversion and Pond

Invert Elev Dn (ft)	= 7.57
Pipe Length (ft)	= 33.24
Slope (%)	= 2.17
Invert Elev Up (ft)	= 8.29
Rise (in)	= 36.0
Shape	= Circular
Span (in)	= 36.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

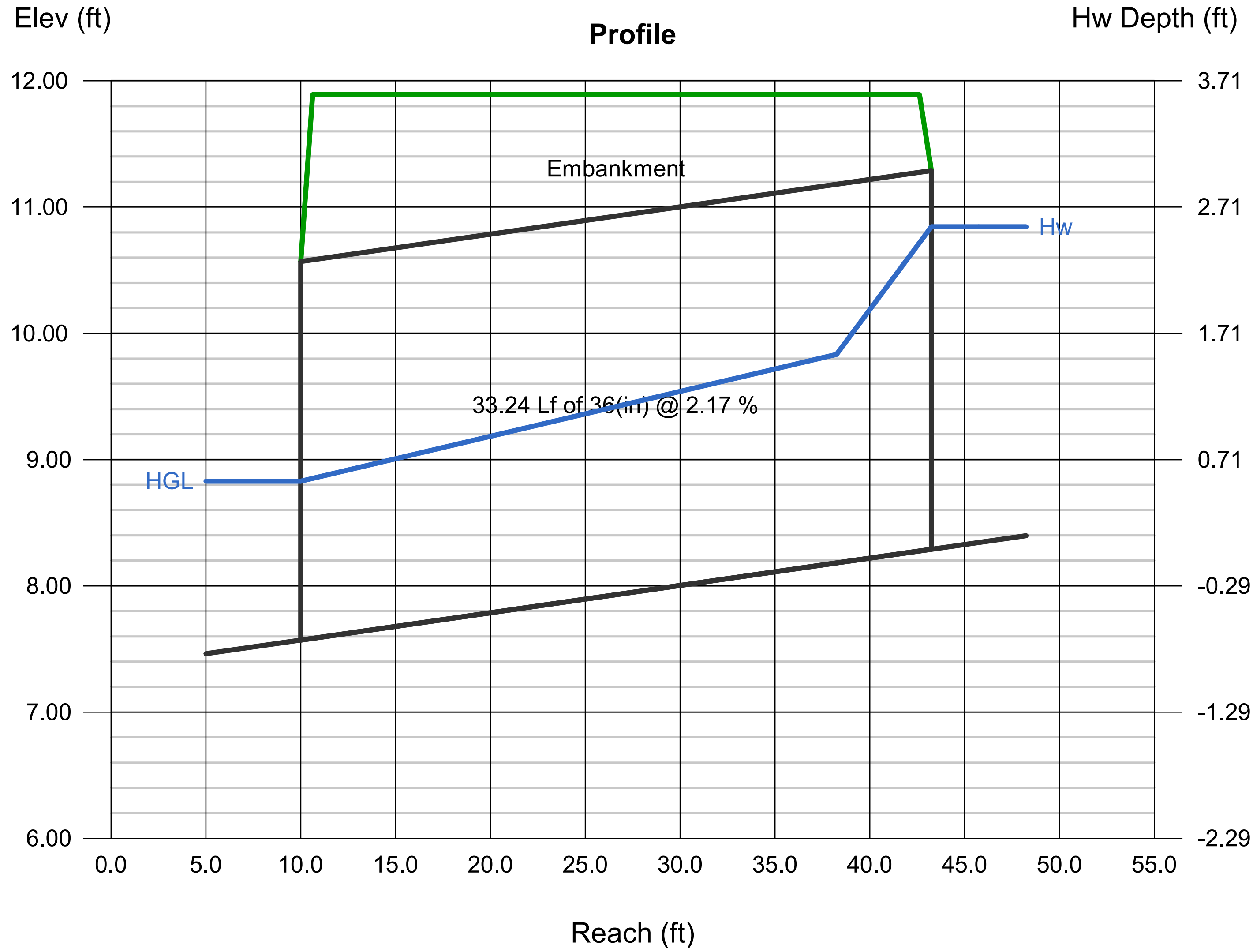
Top Elevation (ft)	= 11.89
Top Width (ft)	= 32.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 80.00
Qmax (cfs)	= 85.00
Tailwater Elev (ft)	= Normal

Highlighted

Qtotal (cfs)	= 85.00
Qpipe (cfs)	= 85.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 10.06
Veloc Up (ft/s)	= 6.76
HGL Dn (ft)	= 8.83
HGL Up (ft)	= 10.01
Hw Elev (ft)	= 10.85
Hw/D (ft)	= 0.85
Flow Regime	= Inlet Control



Culvert Report

Culvert 4 50yr Existing Conditions

Invert Elev Dn (ft)	=	1.31
Pipe Length (ft)	=	50.42
Slope (%)	=	1.27
Invert Elev Up (ft)	=	1.95
Rise (in)	=	18.0
Shape	=	Elliptical
Span (in)	=	30.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

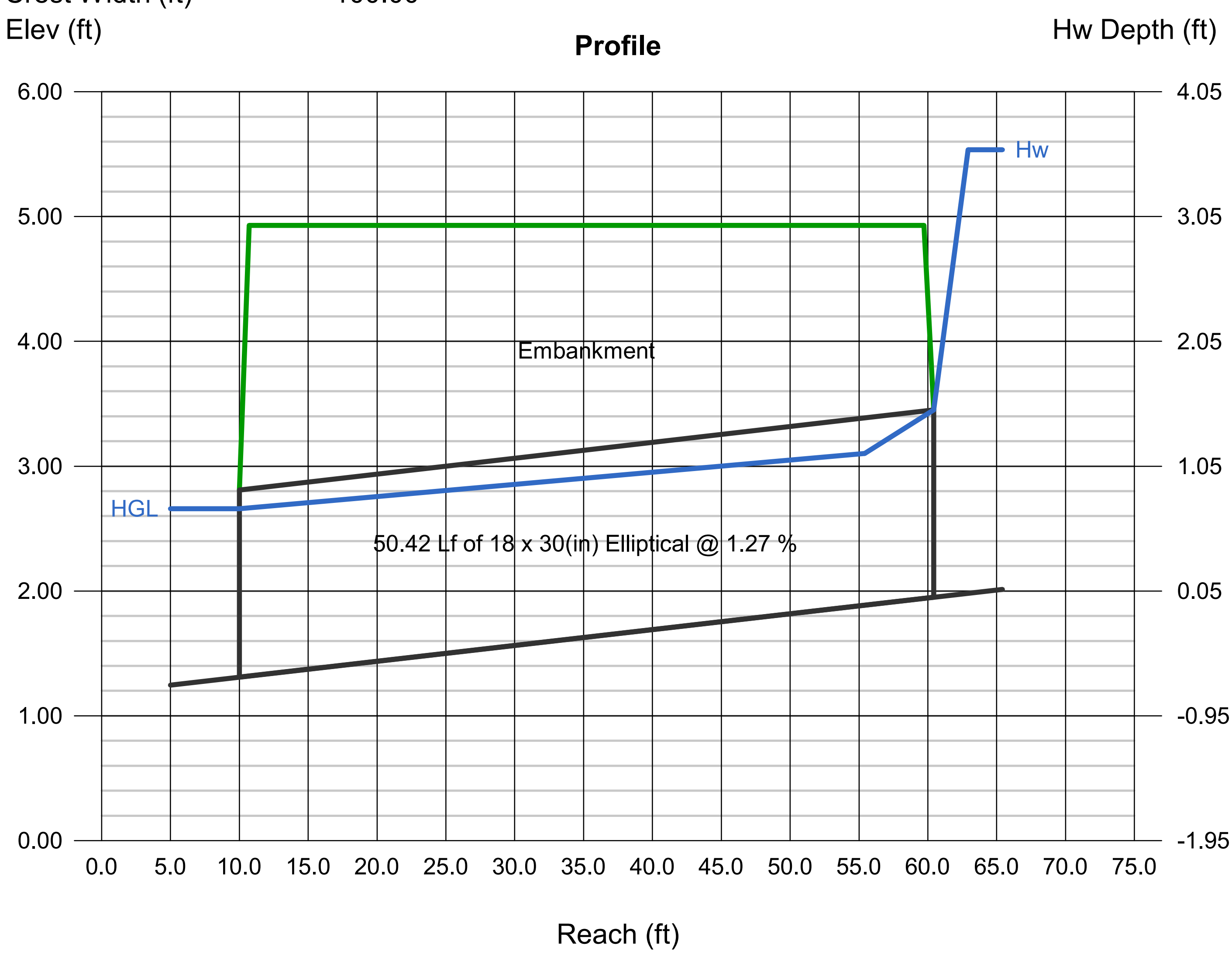
Top Elevation (ft)	=	4.93
Top Width (ft)	=	49.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	228.03
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	220.00
Qpipe (cfs)	=	71.29
Qovertop (cfs)	=	148.71
Veloc Dn (ft/s)	=	8.40
Veloc Up (ft/s)	=	9.27
HGL Dn (ft)	=	2.66
HGL Up (ft)	=	3.15
Hw Elev (ft)	=	5.54
Hw/D (ft)	=	2.39
Flow Regime	=	Inlet Control



Culvert Report

Culvert 4 100yr Existing Conditions

Invert Elev Dn (ft)	= 1.31
Pipe Length (ft)	= 50.42
Slope (%)	= 1.27
Invert Elev Up (ft)	= 1.95
Rise (in)	= 18.0
Shape	= Elliptical
Span (in)	= 30.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Horizontal Ellipse Concrete
Culvert Entrance	= Square edge w/headwall (H)
Coeff. K,M,c,Y,k	= 0.01, 2, 0.0398, 0.67, 0.5

Embankment

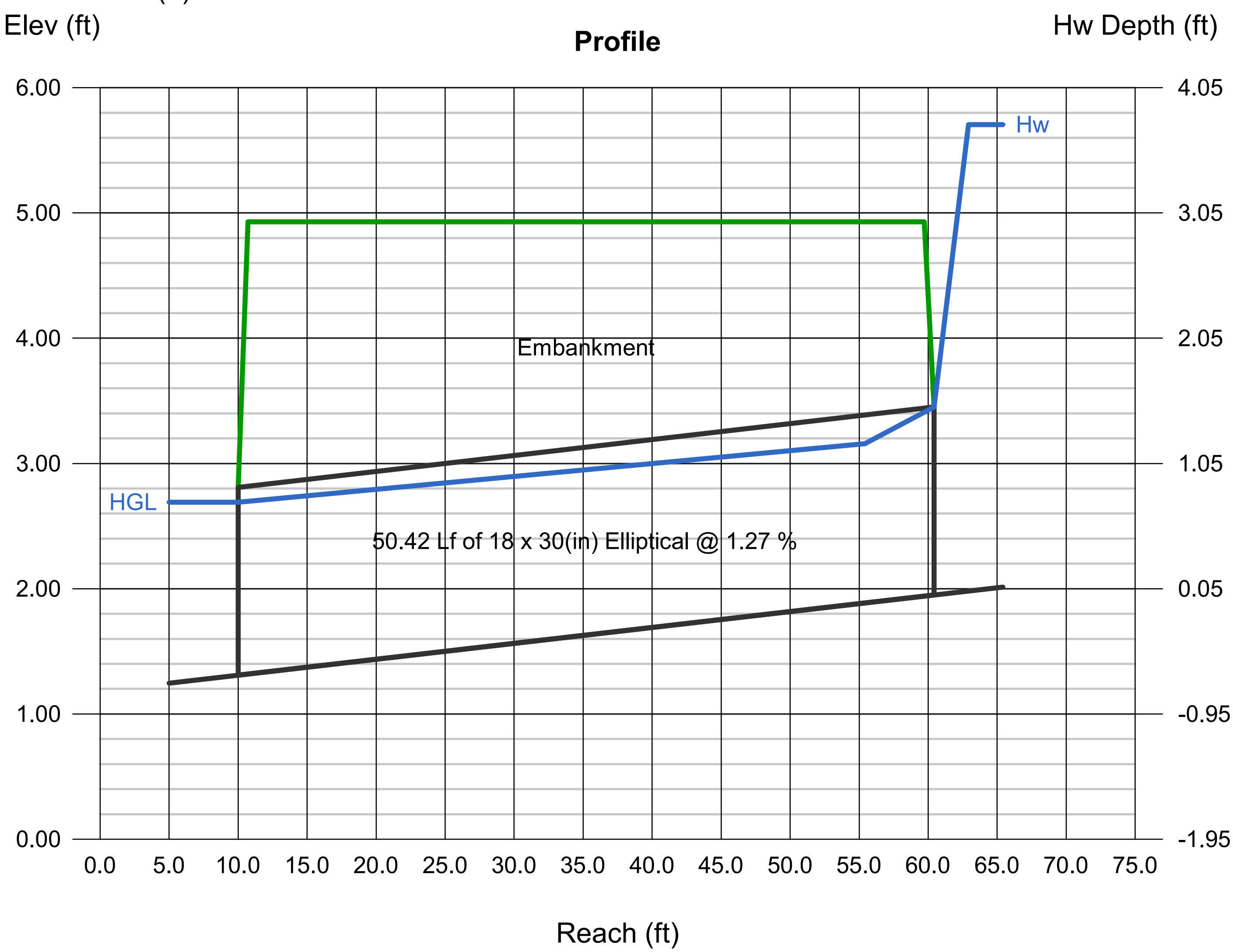
Top Elevation (ft)	= 4.93
Top Width (ft)	= 49.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 200.00
Qmax (cfs)	= 287.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 287.00
Qpipe (cfs)	= 73.57
Qovertop (cfs)	= 213.43
Veloc Dn (ft/s)	= 8.45
Veloc Up (ft/s)	= 9.20
HGL Dn (ft)	= 2.69
HGL Up (ft)	= 3.21
Hw Elev (ft)	= 5.70
Hw/D (ft)	= 2.50
Flow Regime	= Inlet Control



Culvert Report

Culvert 4 50yr With Diversion and Pond

Invert Elev Dn (ft)	=	1.31
Pipe Length (ft)	=	50.42
Slope (%)	=	1.27
Invert Elev Up (ft)	=	1.95
Rise (in)	=	18.0
Shape	=	Elliptical
Span (in)	=	30.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

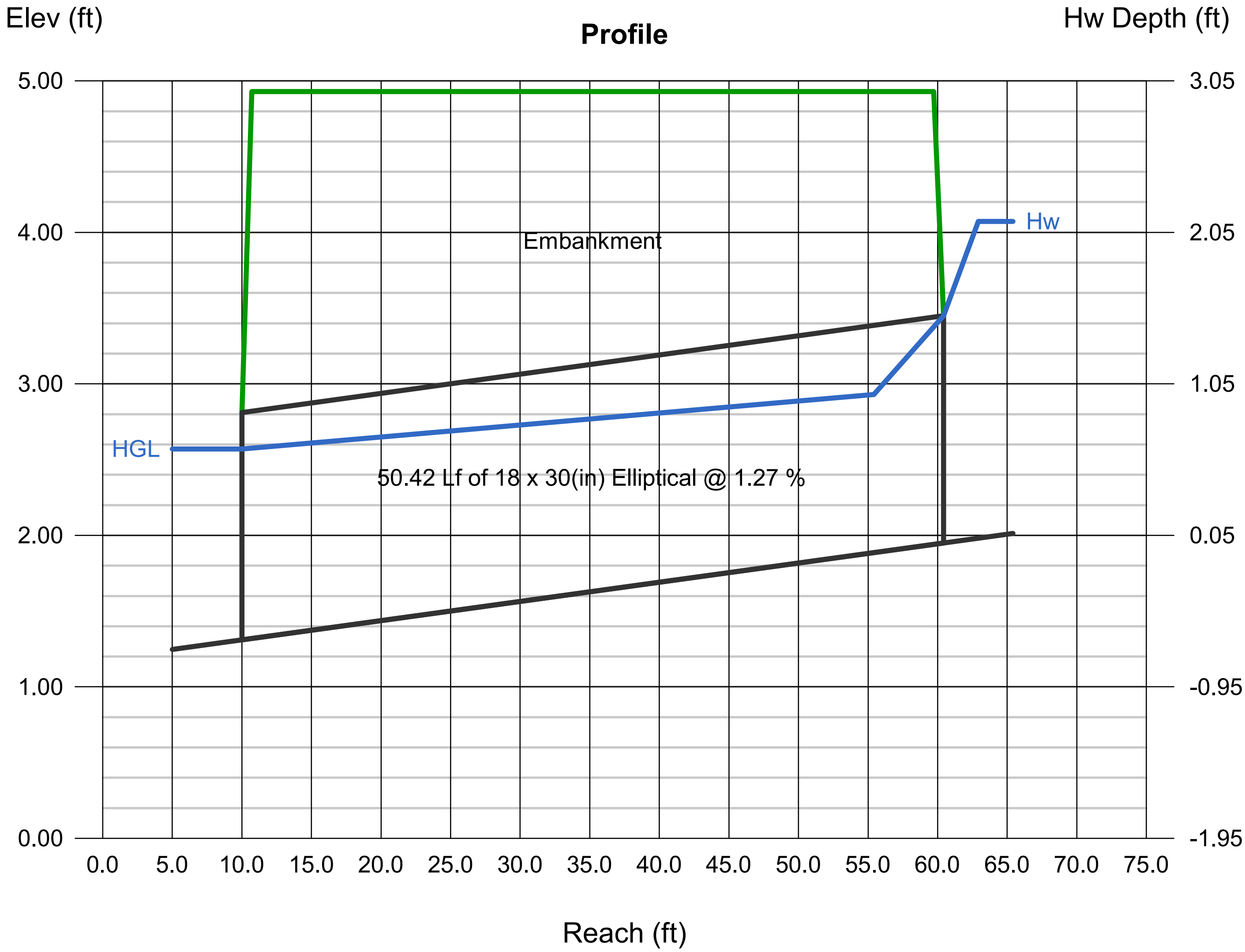
Top Elevation (ft)	=	4.93
Top Width (ft)	=	49.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	35.00
Qmax (cfs)	=	47.37
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	47.00
Qpipe (cfs)	=	47.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.88
Veloc Up (ft/s)	=	7.09
HGL Dn (ft)	=	2.57
HGL Up (ft)	=	2.97
Hw Elev (ft)	=	4.07
Hw/D (ft)	=	1.41
Flow Regime	=	Inlet Control



Culvert Report

Culvert 4 100yr With Diversion and Pond

Invert Elev Dn (ft)	= 1.31
Pipe Length (ft)	= 50.42
Slope (%)	= 1.27
Invert Elev Up (ft)	= 1.95
Rise (in)	= 18.0
Shape	= Elliptical
Span (in)	= 30.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Horizontal Ellipse Concrete
Culvert Entrance	= Square edge w/headwall (H)
Coeff. K,M,c,Y,k	= 0.01, 2, 0.0398, 0.67, 0.5

Embankment

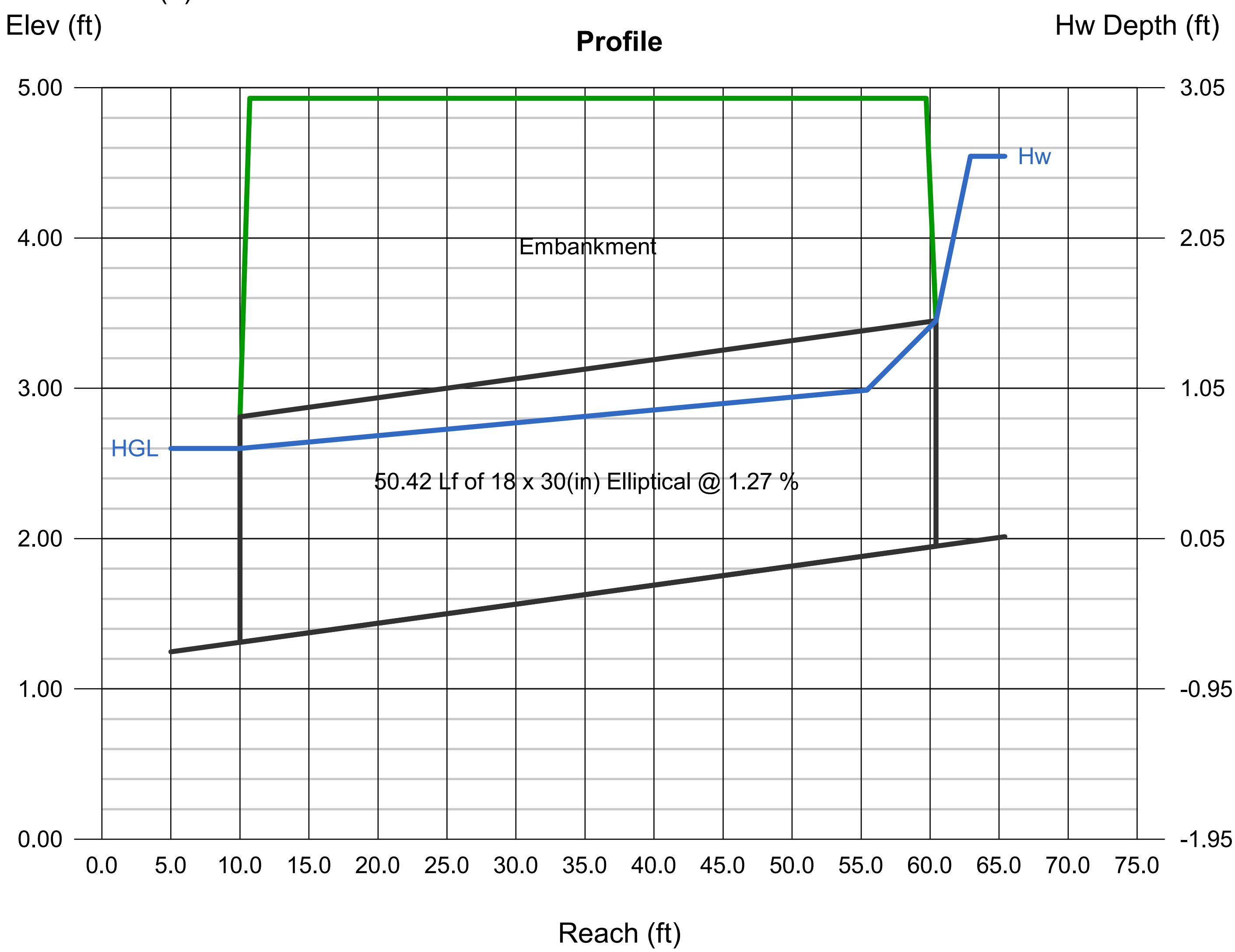
Top Elevation (ft)	= 4.93
Top Width (ft)	= 49.00
Crest Width (ft)	= 100.00

Calculations

Qmin (cfs)	= 35.00
Qmax (cfs)	= 56.85
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 56.00
Qpipe (cfs)	= 56.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.78
Veloc Up (ft/s)	= 7.97
HGL Dn (ft)	= 2.60
HGL Up (ft)	= 3.03
Hw Elev (ft)	= 4.54
Hw/D (ft)	= 1.73
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Sunday, Mar 5 2017

Culvert 6, 50yr

Invert Elev Dn (ft)	=	2.90
Pipe Length (ft)	=	31.50
Slope (%)	=	0.51
Invert Elev Up (ft)	=	3.06
Rise (in)	=	24.0
Shape	=	Elliptical
Span (in)	=	42.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Square edge w/headwall (H)
Coeff. K,M,c,Y,k	=	0.01, 2, 0.0398, 0.67, 0.5

Embankment

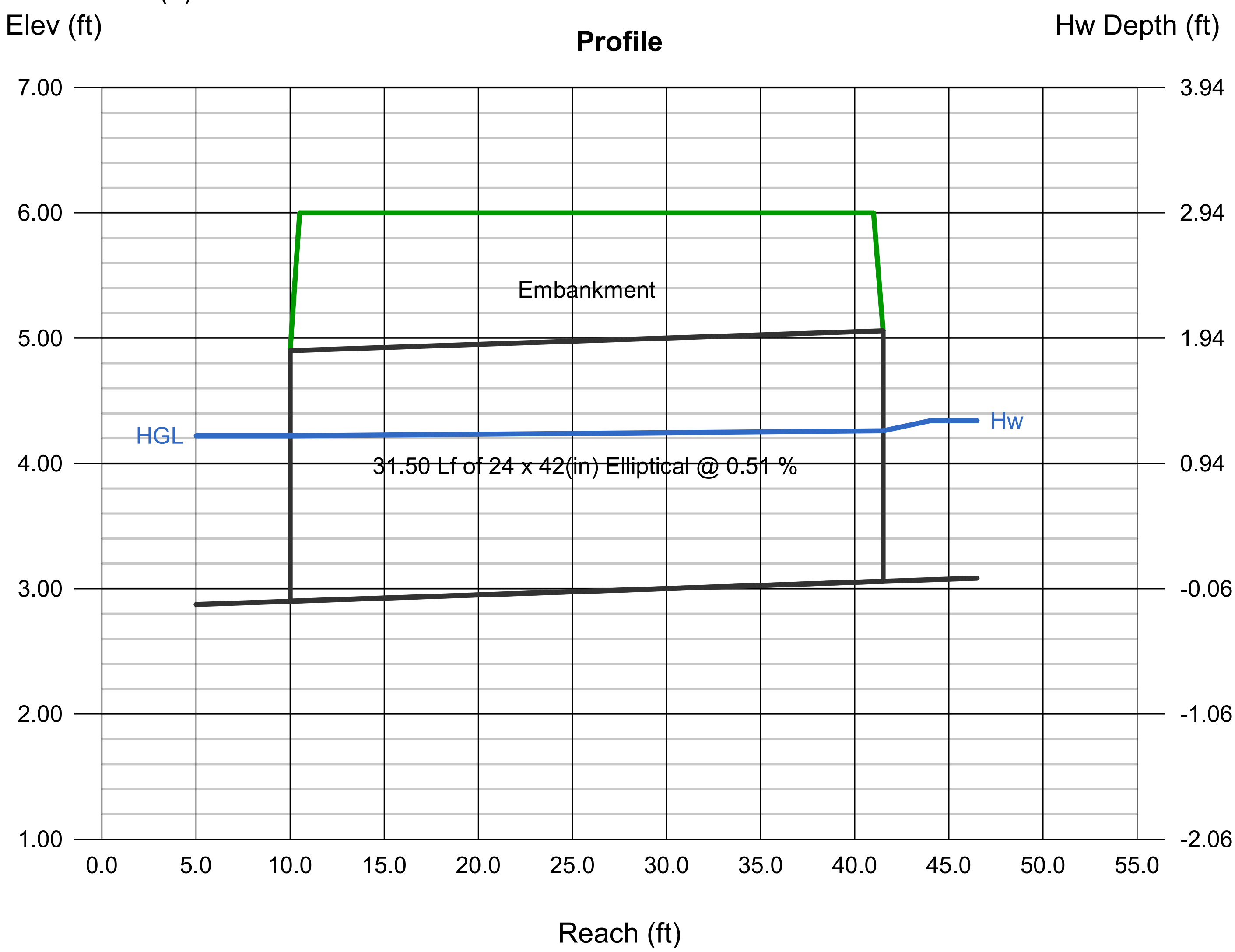
Top Elevation (ft)	=	6.00
Top Width (ft)	=	30.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	20.75
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	20.00
Qpipe (cfs)	=	20.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.62
Veloc Up (ft/s)	=	1.88
HGL Dn (ft)	=	4.22
HGL Up (ft)	=	4.26
Hw Elev (ft)	=	4.34
Hw/D (ft)	=	0.64
Flow Regime	=	Outlet Control



Culvert Report

Culvert 6, 100yr

Invert Elev Dn (ft)	=	2.90
Pipe Length (ft)	=	31.50
Slope (%)	=	0.51
Invert Elev Up (ft)	=	3.06
Rise (in)	=	24.0
Shape	=	Elliptical
Span (in)	=	42.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Groove end w/headwll (H)
Coeff. K,M,c,Y,k	=	0.0018, 2.5, 0.0292, 0.74, 0.2

Embankment

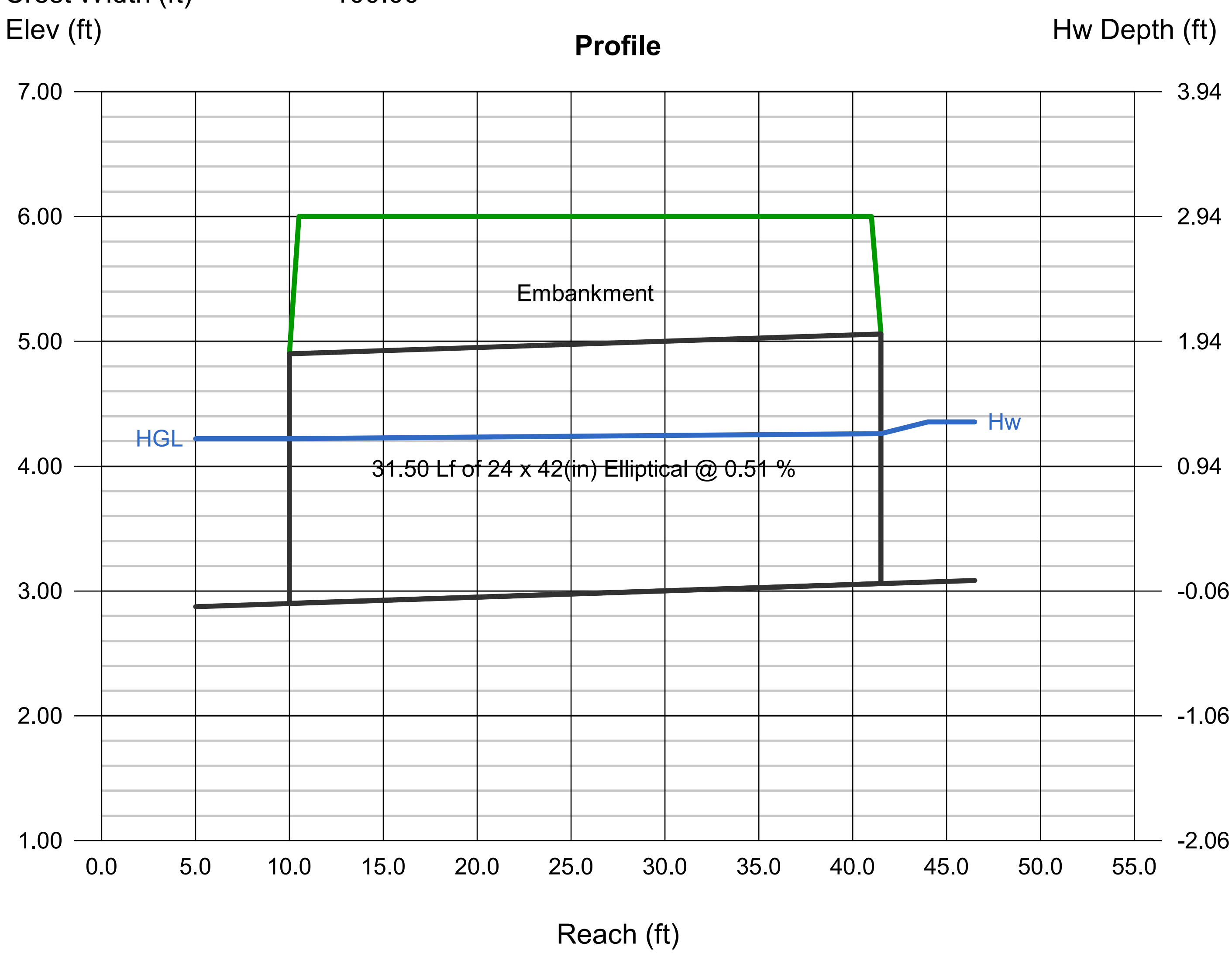
Top Elevation (ft)	=	6.00
Top Width (ft)	=	30.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	24.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	24.00
Qpipe (cfs)	=	24.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.94
Veloc Up (ft/s)	=	2.26
HGL Dn (ft)	=	4.22
HGL Up (ft)	=	4.26
Hw Elev (ft)	=	4.35
Hw/D (ft)	=	0.65
Flow Regime	=	Outlet Control



Culvert Report

Culvert 6, 50yr w Diversion & Pond

Invert Elev Dn (ft)	=	2.90
Pipe Length (ft)	=	31.50
Slope (%)	=	0.51
Invert Elev Up (ft)	=	3.06
Rise (in)	=	24.0
Shape	=	Elliptical
Span (in)	=	42.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Groove end w/headwll (H)
Coeff. K,M,c,Y,k	=	0.0018, 2.5, 0.0292, 0.74, 0.2

Embankment

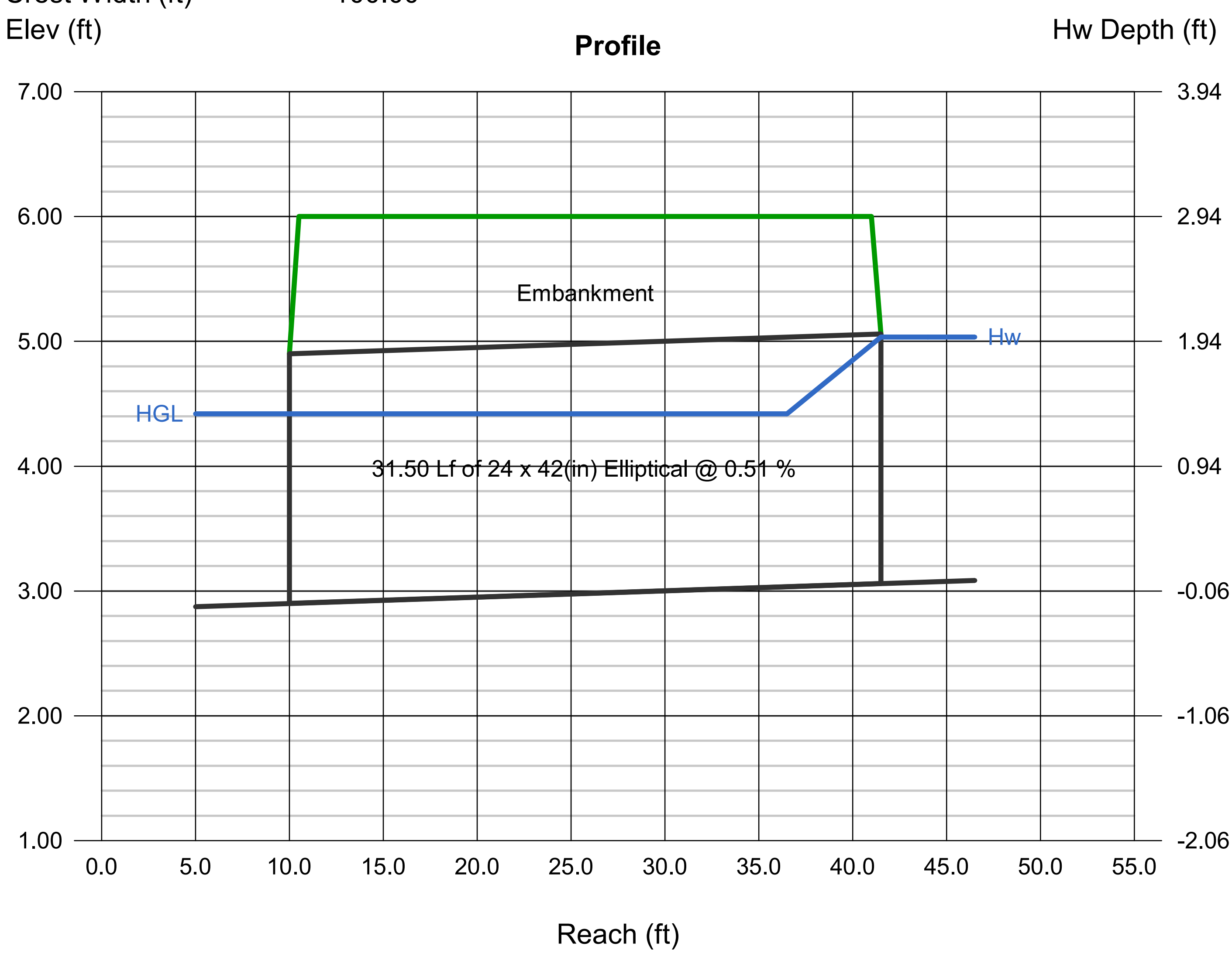
Top Elevation (ft)	=	6.00
Top Width (ft)	=	30.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	65.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	65.00
Qpipe (cfs)	=	65.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.72
Veloc Up (ft/s)	=	5.25
HGL Dn (ft)	=	4.42
HGL Up (ft)	=	4.42
Hw Elev (ft)	=	5.03
Hw/D (ft)	=	0.99
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Mar 6 2017

Culvert 6, 100yr w Diversion & Pond

Invert Elev Dn (ft)	=	2.90
Pipe Length (ft)	=	31.50
Slope (%)	=	0.51
Invert Elev Up (ft)	=	3.06
Rise (in)	=	24.0
Shape	=	Elliptical
Span (in)	=	42.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Horizontal Ellipse Concrete
Culvert Entrance	=	Groove end w/headwll (H)
Coeff. K,M,c,Y,k	=	0.0018, 2.5, 0.0292, 0.74, 0.2

Embankment

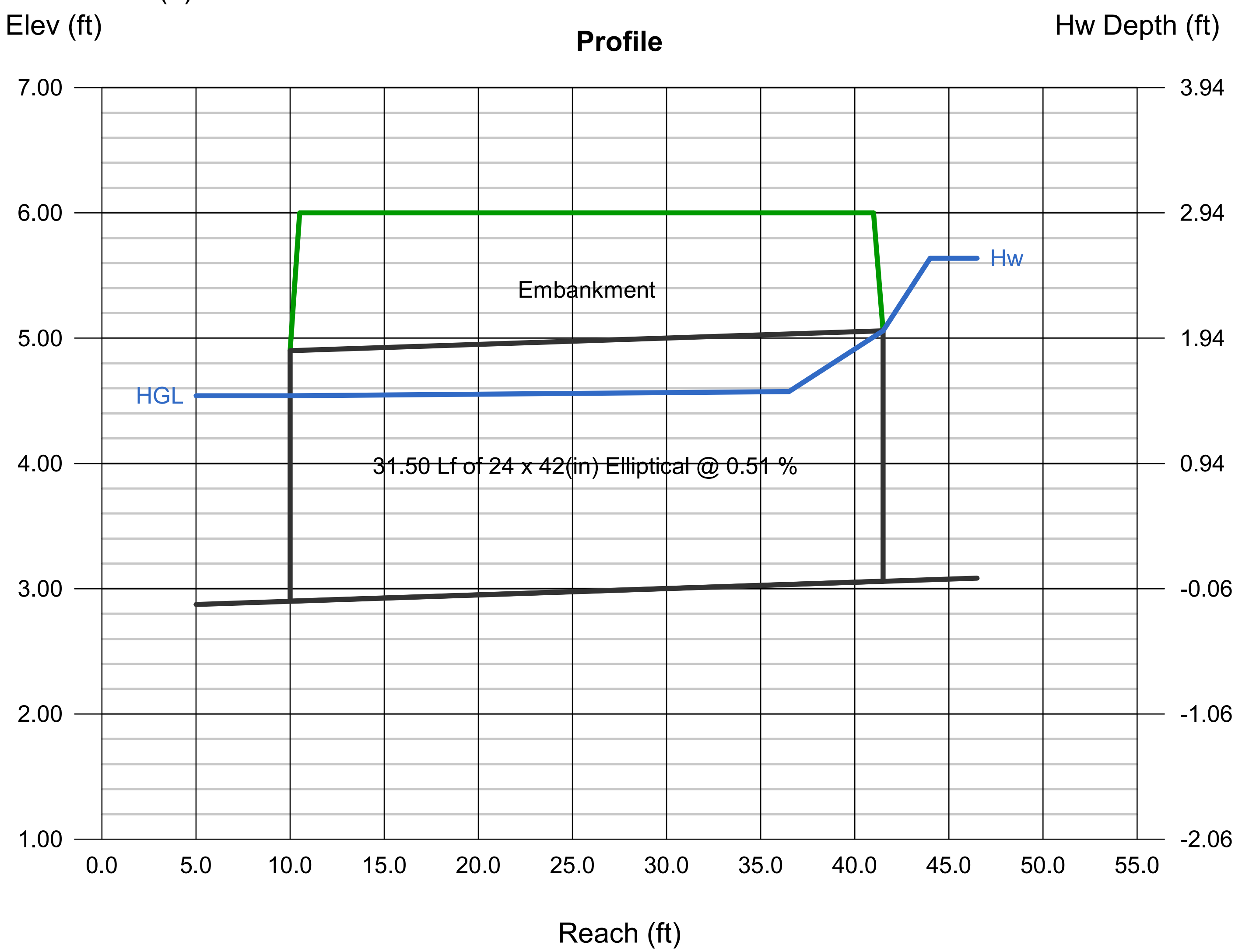
Top Elevation (ft)	=	6.00
Top Width (ft)	=	30.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	100.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	100.00
Qpipe (cfs)	=	100.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.70
Veloc Up (ft/s)	=	7.26
HGL Dn (ft)	=	4.54
HGL Up (ft)	=	4.58
Hw Elev (ft)	=	5.64
Hw/D (ft)	=	1.29
Flow Regime	=	Inlet Control



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ENCLOSURE (D)

CONSTRUCTION COST ESTIMATE

Construction Cost Estimate

Pond Cost Estimate				
Item	**Pond Value**	**Unit**	**Unit Price**	**Total Cost**
Grading w/o Haul off	1426	CY	$ 8	$ 11,407
Reseed	1.5	acre	$ 1,200	$ 1,800
Finishing	2511	SY	$ 1	$ 2,511
Replace Topsoil	2511	SY	$ 6	$ 15,067
Construction Entrance	1	unit	$ 1,200	$ 1,200
Fill for Dam	1070	CY	$ 15.00	$ 16,050
Total				$ 48,035

Pond Values	
1.5	acres
67801	ft^2 (Pond Area)
2511	SY (Pond Area)

Ditch Repair (South of Culvert 2)	
~100 yards	$ 5,000

Concrete Channel Estimate				
Item	**Dimension**	**Unit Price**	**Unit**	**Total Cost**
Base	196	$ 700	cy	$ 137,407
Walls	79	$ 700	cy	$ 54,963
			Total	$ 192,370

Note: Channel features a base of 8ft, walls of 2ft and concrete depth of 1ft.

Note: Concrete estimate includes cost of concrete + excavation + refill

Concrete Structure Cost Estimate			
Item	**Unit Price**	**Unit**	**Total Cost**
Concrete	$ 750.00	cy	$ 14,666.67
Total			$ 14,666.67

Concrete Values	
528	cf
19.56	cy

Note: Concrete estimate includes cost of concrete + excavation + refill

Note: Estimations were calculated from numbers received from lead estimator at Jones Bros. Contractors

ENCLOSURE (E)

MAINTENANCE AGREEMENT

City of Pegram Maintenance Agreement

A consistent maintenance program is the best way to ensure that your detention basin will continue to perform its water quality and flood control functions. Refer to your copy of the detention basin plan from the Pegram Senior Design Team for any questions as to how the detention basin is designed to function.

In general, a maintenance program should contain the following components:

- regular inspections
- review by a licensed Professional Civil Engineer
- vegetation management
- embankment and outlet stabilization
- debris and litter control
- sediment/pollution removal

The storm sewer system includes pipes, catch basins and the outlet structures that enter and exit the detention basin. It is important to regularly inspect the structural elements (inlet/outlet pipes) of your detention basin in order to ensure that storm water is flowing in and out of the pond as originally designed. Debris and sediment commonly clog detention basins and reduce the pond's overall effectiveness.

The following maintenance and inspection tasks should be included for the structural basin components: (also see Detention Basin Inspection and Maintenance Record located at the end of this Guide.

1. Inspect the inlet pipes and outlet pipes for structural integrity. (Annually) Check inlet/ outlet pipes for structural integrity to ensure they aren't crumbling or broken.

2. Inspect riprap at the inlet pipes. (Annually) Replace when the riprap is clogged with sediment and debris.

3. Conduct routine inspections for trash or other debris that may be blocking the inlet or outlet pipes or emergency spillway. (Monthly and after rain events)
Remove all trash and debris from the basin. Improperly maintained ponds can harbor breeding area for mosquitos and reduce the storage volume of the pond.

4. Inspect and clean the storm sewer system and catch basins upstream from the detention basin. (Every 5 years or as needed)

5. Inspect for sediment accumulation at the inlet pipes. (Semiannually and after rain events)It’s important to clean out sediment that might be restricting water flow. Remove accumulated sediment with a shovel and wheelbarrow if it is blocking water flow. Small amounts of removed sediment can be spread evenly on upland areas and seeded with natural vegetation.

6. Inspect the stone around the riser/standpipe (outlet pipe). (Semiannually and after rain events) If stone has accumulated sediment, vegetation and/or debris to an extent that water is not flowing through the stone and out of the pond as originally designed, then the stone should be replaced with clean 3” diameter stone choked with clean 6A stone.

7. Inspect for excess sediment accumulation in the pond (Annually)
Remove every 5-10 years or when the sediment accumulation is more than 6-12”.

8. Have a Professional Civil Engineer inspect the pond to ensure it is functioning properly. (Annually) Compare existing conditions to as-built engineering plans

Property Management:
In addition to these tasks, local homeowners should be educated to the Property management refers to specific activities that they can do to enhance the detention basin and minimize long-term maintenance. A number of these activities are described as follows:

1. Do not use pesticides, herbicides, or fertilizers in the ponds. These products will leach from the pond and pollute the water-decreasing the overall quality of groundwater
2. Do not place yard waste such as leaves, grass clippings or brush in the detention pond or in the storm drains located in the streets. These materials release excess nutrients as they decompose and will lead to more algae growth in the pond.
3. Do not dump any materials in the storm sewer system. Improperly disposed of materials will pollute the basin.
4. If you must use fertilizers, only use low-phosphorus, slow-release varieties. Keep fertilizers on the lawn and not on paved areas.
5. Pick up and dispose of pet waste with your weekly garbage.
6. Provide educational updates to the property owners. Discuss your maintenance plan at regular meetings, provide information in newsletters, and host annual clean-up days

Thank you in advance for your cooperation in maintaining the integrity and quality of your detention pond in efforts to improve water quality and overall performance.

City of Pegram Inspection and Maintenance Record

Task	Inspection Frequency	Year ________		
		Engineer	Cost	Notes
Inspect inlet pipes and outlet pipe for structural integrity	Annually			
Inspect riprap at inlet pipes	Annually			
Conduct routine inspections for trash or other debis that may be blocking the inlet or outlet pipes	Monthy/ After Rainfall Events			
Inspect and clean catch basins upstream	Every 5 years			
Inspect for sediment and trash accumulation at the inlet pipes	Semiannually/ After Rainfall Events			
Inspect for excess sediment accumulation in the pond	Annually			
Remove accumulated sediment at basin inlet	Semiannually/ After Rainfall Events			
Have a Professional Civil Engineer inspect the pond	Annually			
Inspect side slopes, berms and spillways for erosion	Annually/ After Rainfall Events			
Re-establish natural vegetation on eroded slopes	Annually			
Inspect basin for signs of chemicals. Remove/dispose of properly	Monthly			
Review Maintenance Plan	Annually			

Enclosure (F):

Man Hour Log & Timesheets

Final Man Hour Comparison

Category	**Estimated Hours**	**Hours To Date**
Project Management		
Management	192	195
Phase 1: Site Investigation		
Investigation	8	13
Phase 2: Survey		
Survey	93	115
Preliminary Design		
Hydraulic Analysis	62	15
Preliminary Solutions	72	41
Final Design		
Design Work	240	200
Totals	667	579

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Enclosure (G):

Meeting Minutes

From: **Abigail Queen** queenaj@mail.lipscomb.edu
Subject: September 13, 2016 Minutes
Date: September 13, 2016 at 9:27 AM
To: nrcurtis@mail.lipscomb.edu, cjreid@mail.lipscomb.edu, David Lowery loweryda@mail.lipscomb.edu, Cody Glenn caglenn@mail.lipscomb.edu, Chris Gwaltney cagwaltney@lipscomb.edu

Q

Civil Engineering Senior Capstone Sequence
At 8:00 a.m. on Tuesday, September 13, 2016, four members of the Pegram Flood Control Project called a meeting in Hughes Engineering Center at Lipscomb University.
The following members of team were present:
Christian Reid
Nathan Curtis
DA Lowery
Abby Queen
In addition to the team members present, Cody Glenn is also a member of the PFC Team but was not in attendance. Professor Chris Gwaltney was also in attendance.
Report:
Pegram Team spoke about the alterations and enhancements of tasks- specifically the Project management. Also added man hours and some subtasks. First order of business will be to research historical data. Abby will take CSX and Socioeconomic historical data. Christian will take rainfall and flood data. Nathan will take geological data. Cody will take TDOT data. DA will begin research on the technicalities of working with Primavera and will furthermore be handling conversation between technical advisors. DA will also be contacting the EPA contact to establish a hopeful working relationship. All historical date will tentatively be completed by October 1. Surveying was discussed- a tentative date will be for early november, with a short PFC Team presentation to the Survey Class beforehand. Concrete dates have not been established.
Action: Prof Gwaltney set up DA with Primavera by September 13
Prof gwaltney will give team contact info for mayor, city planner and EPA contact
DA will. speak with technical advisors about client meeting ASAP and Sean Moynahan (EPA contact)

Minutes from Civil Senior Design Team: Pegram

Date: 09/20/2016

Group Members: Abby Queen, D.A. Lowry, Nathan Curtis, Cody Glenn, Christian Reid

All members in attendance

- Key goals of the meeting
  - Find times to meet with town officials
  - Build WBS
  - Set up technical advisor meeting

Update of last week's minutes

Abby- Has gathered socio-economic data and has a CSX contact info. Has reached out to her contact at CSX with little response. Is continuing to try and find a reliable contact.

Cody- Has found two contacts at TDOT. Has reached out via email and is awaiting response.

D.A. - in coordination with EPA rep. about possibly joining the meeting with Pegram Town Officials. D.A. is also coordinating a meeting with the advisement team to take place soon.

Christian- Gathered 6 years of weather record for Pegram. Is currently looking for FEMA flood data and watershed information.

Current action steps

Abby- **Talking to CSX contact about data availability** (completion of Oct. 1)

Nathan- **Gather geo data to include maps and soil data** (completion of Oct. 1)

Cody- **Gathering TDOT data through contacts or online** (by Oct. 1)

D.A.- **Will coordinate meeting with town official, EPA rep and advisors, Awaiting Gwaltney to provide Primavera Software** (by Sept. 27)

- **Will offer available meeting time as Any Tuesday or Thursday by 7 am with a need to be back in Nashville by 2:30 pm. Anticipated meeting time is 2 hrs.**

- **Technical advisor meeting by next Thursday**

Christian- **Will try and determine flood depths using FEMA, cull data on weather for applications** (By Oct. 1)

Group Action: finished initial WBS with tasks and man hours. **Action Step: work with advisors to fill in any gaps in initial WBS. Completed by Oct. 1**

Action Step: Gwaltney to give D.A. Primavera by Oct. 4

September 29, 2016
Hughes Engineering Center 5:30
the following members of the team were present:
Abby Queen
Christian Reid
Cody Glenn
DA Lowery
Nathan Curtis

The following technical advisors were present:
Peter Chimera
Matt Lackey

Note for team: ACME mapper topo view is helpful for aerial site view

Members informed advisors of the details of the project
Peter has been informed by local residents that there is a large gasline located between the highway and the railroad
Abby explained that shes been having difficulty contacting and gathering info from CSX. Peter may have a contact with a local

Mr. Lackey advises
gather data about the problem (ie: culvert sizes, watershed, and rainfall data) Find where the water is going will be key

gather data for contributing area from a topo map and export to CAD
explore other possible solutions (detention ponds or tanks OR just improve flooding ditches if the problem is manageable)
2. Prepare preliminary cost estimates of possible solutions
For PSD, prelim proposal should include: delineate drainage basins, exclude survey, analyze culverts, find initial flows going into the culverts. Work to find the project scope through these work tasks
look for improvements in the flooding ditches
3. Prepare a real deliverable: Find storm data and what year storm we want to design
include tdot requirements for culvert sizes for railroad crossings)
Inform the city of Pegram that the culverts are only passing the 2 year storm when they should be passing the 10 or 25 year storm
4. Research the requirements for utilities, TDOT, CSX. Make sure there are no other utilities that our project will be concerned with. Include right of way from TDOT regualtions

Peter advises similarly, to
Go look at the problem and talk to the surrounding property owners. Ask Pegram Mayor what the project budget actually is
Prepare cost estimates including our hours for design and project management
Include survey hours as part of cost estimate

Both advisors say its a bit backwards in that we should do the design in phases, where we need to do a bit of design and gather information before putting the final price before the client

ACTION:
talk to mayors office about the project scope, practicalities of working with private entities
Peter Chimera to Abby Queen concerning CSX contact

All members need to go look at project area during a hard rainfall
DA to follow up with Mr. Lackeys contact for easement data
Christian to look up historical storm data from NOAH

10/11/2016

Minutes

Members Present:
DA Lowery
Cody Glenn
Abby Queen
Christian Reid
Nathan Curtis
Chris Gwaltney

Also Present:
Mayor Morehead

Culverts that run under Highway 70

Mayor: The Parking lot surrounding the culver looks like a lake 3-4 times a year. The water doesn't top Highway 70 very often though. Most of the complaints are from Small businesses. The water travels west along 70 from the gas station on the North side of the highway towards the 3 culverts that run under the highway.

DA: We should survey the whole parking lot (in front of Citgo)

Mayor: The ditch runs back into the hills (north) and catches a lot of water from there.

Mayor: Barriers along the ditch need to be fixed however the state says they don't have money and there is dispute among the residents as to whether the land belongs to the government or is private property. There is also a problem at the westward culvert (in front of Parts City) however the water does not get up to Parts City.

DA: We need to Survey from the Cash Express east to Janette Relators.

Mayor: We haven't found the sink hole and it may have been filled. There are a lot of sinkholes in Pegram, I ran into one in my backyard 20 years ago at my House when I was mowing. My house is at the bottom of the hills.

DA: Will TDOT pay any money towards fixing this problem?

Christian: We will prove that this culvert does not meet TDOT's standards.

Mayor: The drainage ditch does go through private property and runs from miles into the hills. It will be hard to get onto people's land to mess with the ditch.

Christian: The solution should be near highway 70/

Gwaltney: Who have you talked to at TDOT?

Mayor: We talked to the head of district from Clarksville. He doesn't think the water is coming from the natural reserve that sits back in the hills. The property owners want the flooding to be fixed and may even allow you to alter their land.

Christian: We plan to come up with 3 or 4 plans and let you choose.

Mayor:	We lose businesses to flooding. TDOT cuts the grass in the ditch maybe one a year. There is no property tax in Pegram so we can't get a grant. I am planning to bring up a property tax at the next city meeting. There are 3500 people and 1300 of them are voters. They are mostly older and retired and don't want to spend money.
Christian:	What is the cost of flood damage to a building?
Mayor:	I'm not sure, but I think quite a bit. It costs several thousand dollars at least.
DA:	If we prove to TDOT that we have a solution who would pay for it?
Mayor:	TDOT would pay and do the work.
DA:	So grant money won't help?
Mayor:	TDOT could allow Pegram to do it.
Christian:	Could we get land from the hills?
Mayor:	There are people up there who would probably be willing to donate some land.
DA:	One solution may be a detention pond in the hills.
Mayor:	There may be one up there.
Gwaltney:	Should we go through you to get to the land owners.
Mayor:	I don't care.
Mayor:	Brad Evans is the City Engineer.
DA:	What are the chances on making a detention pond?
Mayor:	We need to talk to the lady at 4448 or 4449 (Hannah Ford?)
DA:	The Pond may be back in the trees.
Gwaltney:	It sounds like they took a problem and worked in the middle but not at the ends (referring to culvert that runs under Hannah Ford Rd) Could we do ditch improvements?

Possible Place for detention pond along Hannah Ford Road

Mayor: The ditch was not this big when I moved here.

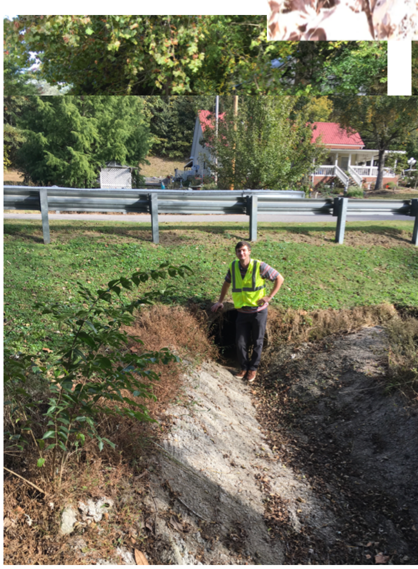
RESIDENT: There was not ditch when I moved here. The water doesn't get above the wood wall my husband built. There was a kid who almost drowned here. It wasn't a problem until the houses were built in the north.

Ditch that runs along the edge of the RESIDENT'S property. Was not there when RESIDENT moved in.

Wall built by RESIDENT'S husband

Christian: There are some big rocks that get washed down here.

DA: We will be doing a survey in early November.



Looking toward culvert that runs under Hannah Ford Road (causing ditch).

Culvert that runs under driveway along Hannah Ford Road

Ditch that runs south Under Hannah Ford Road

Meeting Minutes

10/18/2016

Members in attendance: Christian, Nathan, Abby, Cody, DA

Advisors in attendance: Prof. Gwaltney

We discussed the new layout for the shared drive folder to include locations of all files. Group members all now have OneDrive on computer for ease of access to files.

We reviewed the work breakdown structure, tasks and hours were agreed upon by all members. **Action Item: DA will finish schedule in Primavera P6, due 10/25/2016.**

Action item sections for proposal due from all member 10/25/2016 for review by group. Submittal of final proposal due 11/1/2016.

Action item survey boundary and presentation for survey class completed by Cody 10/25/2016

Action item the group will make a site visit to establish benchmark prior to surveying trip, which is on 11/5/2016. DA will coordinate with Mayor Moorehead to get permission for access to survey area. Group will provide a list to professor 4- 5 days prior to benchmark establishment trip. Date TBD based on coordination with mayor.

technical advisor meeting minutes
February 28, 2017
5:00 PM
all members of Pegram Senior Design present
Professor Chris Gwaltney present
Technical Advisors:
Matt Lackey
Justin
Peter Chimera

need drainage maps: delineation of large culvert and watershed of each area
    USGS Topo
    show land use to explain curve numbers
    list assumptions for estimated capacity of culverts
    which controls? manning (outlet control) or inlet control
true flow is larger than estimated based on low curve numbers- needs to be at least a curve number of 60

label ditch improvement on proposal
Matt recommendation: create diversion ditch in analysis
What is the capacity of the southern culvert, when it will overtop
and who will diversion impact
give maintenance plan for designed structures

make outlet structure only able to send max amount of capacity to the culverts
split outlet structure

redefine scope as it has unfolded
    may have to assume things, just state an assumption- “dont chase the rabbit down the hole”

give mayor information on existing condition analysis for Pegram to give to TDOT for $$
also schematic design options for senior design project:
    Construction drawings for ditch and pond structures

prove everything in calculations: include addition of culverts and curve number(soil types)
break everything down into components and show work
matt and DA got in a fistfight
matt will bill DA for ripped shirt
come up with a plan to design

RAYMOND B. JONES
COLLEGE OF ENGINEERING

Enclosure (H):

Presentation Slides

LIPSCOMB UNIVERSITY | RAYMOND B. JONES COLLEGE OF ENGINEERING

Enclosure (I):

Reference Material

Welcome to
the Town of Pegram, Tennessee

Main No. 615-646-0773 / FAX 615-646-6869
Town Hall Hours: Monday - Friday, 8 AM-12 PM & 1-4 PM
Sewer Emergency After Hours: 533-2637

"Community Leaders"

Please be advised that e-mail you send to and/or receive from any Town official or staff member may be a public record subject to the Tennessee Public Records Law, T.C.A. §10-7-503.

Pegram Charter - Click Here.

Pegram Codes (Verify with City Hall for any updates) - Click Here.

Charles Morehead	**Mayor, Purchasing Agent, Personnel Supervisor**	mrcourier@att.net	**615-426-3275**
Bill Herbert	**Vice Mayor**	wm358@bellsouth.net	**615-646-6994**
Bob Sanders	**Alderman**	rsand21@aol.com	**615-403-7475**
Aubrey Chambers	**Alderman**	slctoo@bellsouth.net	**615-646-1627**
Warren Miller	**Alderman**	warrenwsm27@aol.com	**615-662-0119**
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Jamie Mrzena	**Town Recorder -** Court Clerk/Accounting Department Head	recorder@pegram.net	**615-646-0773**
Jennie Peters	**Town Clerk -** Front Desk Management	cityhall@pegram.net	**615-646-0773**
James Parks	**Building / Codes Enforcer**		**615-646-0773**
Jim Stinnett	**Sewer Operator**		**615-646-0773**
Larry Martin	**Public Works-** Maintenance Department Head	publicworks@pegram.net	**615-646-0773**
Brad Bivens	**Engineer -** Town Consultant		**615-646-0773**
			615-646-0773
Martha Brooke Perry	**Attorney -** Town Consultant		**615-646-0773**
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Brent Stuart	**PFD Fire Chief** (Volunteer Part-Time)		**615-646-6800**
Nathan Stanley	**PFD Asst. Chief** (Volunteer Part-Time)		**615-646-6800**
.	.		.
Lou Chambers	**Planning Commission**	**slctoo@bellsouth.net**	**615-646-1627**
Charles W. Edens	**Planning Commission**		**615-662-9903**
Gene Hannah	**Planning Commission, Chairman**		**615-646-6616**
Bob Sanders	**Planning Commission**		**615-673-7609**
Melissa McWright	**Planning Commission**		**615-646-3114**
.	.		.
T.J. Kirby	**Board of Zoning Appeals, Chairman**		**615-673-7205**
David Becker	**Board of Zoning Appeals**		
Donnie Dunn	**Board of Zoning Appeals**		
Gary Jackson	**Board of Zoning Appeals**		
Rick Roarke	**Board of Zoning Appeals**		

.	.		
Lou Chambers	**Emergency Management Board -** Director	slctoo@bellsouth.net	**615-646-1627**
Kevin Stewart	**Emergency Management Board** - Assistant Director		**615-646-5098**
Brent Stuart	**Emergency Management Board** - Fire Department Representative		**615-646-0773**
Aubrey Chambers	**Emergency Management Board** - Governing Body Representative		**615-646-1627**
Stoney Greenlee	**Emergency Management Board**		**615-662-0831**
Wanda Kelley	**Emergency Management Board**		**615-977-9871**
Cindy Beirnes	**Emergency Management Board**		**615-646-3022**
Kathy Cundall	**Emergency Management Board**		**615-662-8567**
Mark Beirnes	**Emergency Management Board**		**615-646-3022**
Barry Mangrum	**Emergency Management Board**		**615-533-9636**

Sheriff's Office: 792-4341
(Enforcement for Town of Pegram)

Pegram **Sewer Emergency** After Hours: 533-2637 or **533-2461**

Animal Control: 792-3647 / Landfill & Recyling Center: 792-7538

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United States Department of Agriculture

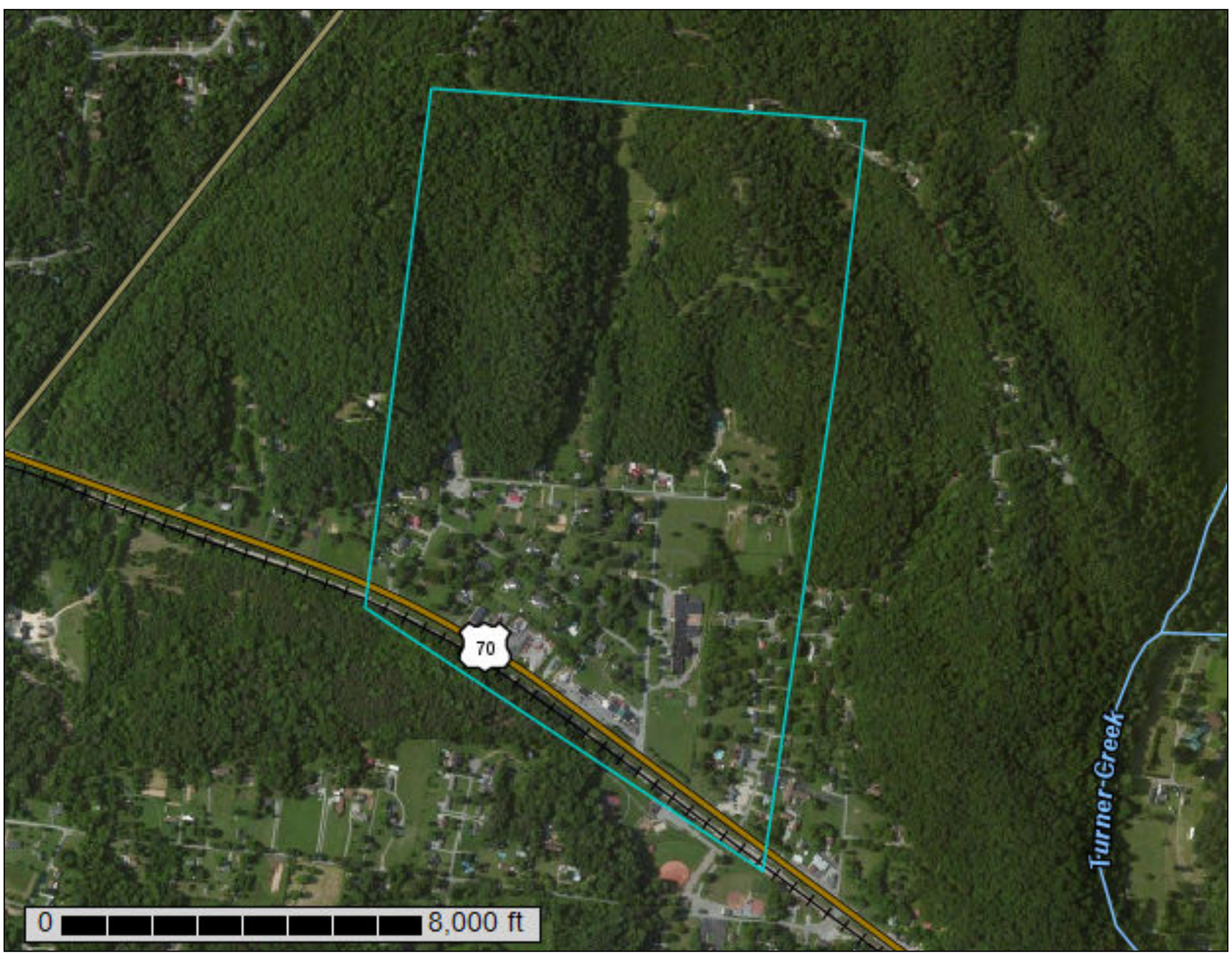
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Cheatham County, Tennessee



January 31, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:8,310 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Cheatham County, Tennessee
Survey Area Data: Version 10, Sep 11, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 17, 2011—May 30, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Cheatham County, Tennessee (TN021)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AmB2	Armour silt loam, 2 to 5 percent slopes	23.8	10.5%
AmC2	Armour silt loam, 5 to 12 percent slopes	0.0	0.0%
ByB2	Byler silt loam, 2 to 5 percent slopes, eroded	53.3	23.4%
En	Ennis gravelly silt loam, occasionally flooded	12.8	5.6%
HaC	Hawthorne gravelly silt loam, 5 to 12 percent slopes	17.7	7.8%
HaD	Hawthorne gravelly silt loam, 12 to 20 percent slopes	16.7	7.3%
HsF	Hawthorne-Sulphura association, steep	68.1	29.9%
HuB	Humphreys gravelly silt loam, 2 to 5 percent slopes	12.6	5.5%
MnD2	Minvale gravelly silt loam, 12 to 20 percent slopes, eroded	22.7	10.0%
Totals for Area of Interest		**227.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Cheatham County, Tennessee

AmB2—Armour silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2td31
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Armour and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Armour

Setting

Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Silty alluvium over clayey residuum weathered from phosphatic limestone

Typical profile

A - 0 to 19 inches: silt loam
Bt - 19 to 58 inches: silty clay loam
BC - 58 to 79 inches: clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Byler

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Arrington

Percent of map unit: 4 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Mimosa

Percent of map unit: 2 percent
Landform: Escarpments
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

AmC2—Armour silt loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2td32
Elevation: 500 to 850 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Armour and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Armour

Setting

Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread

Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Silty alluvium over clayey residuum weathered from phosphatic limestone

Typical profile

A - 0 to 19 inches: silt loam
Bt - 19 to 58 inches: silty clay loam
BC - 58 to 79 inches: clay

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Byler

Percent of map unit: 4 percent
Landform: Stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Dellrose

Percent of map unit: 4 percent
Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Mimosa

Percent of map unit: 2 percent
Landform: Escarpments
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex

Hydric soil rating: No

ByB2—Byler silt loam, 2 to 5 percent slopes, eroded

Map Unit Setting

National map unit symbol: kpd6
Elevation: 400 to 700 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 190 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Byler and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Byler

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium over clayey residuum weathered from limestone

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 24 inches: silt loam
H3 - 24 to 44 inches: silty clay loam
H4 - 44 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: About 24 inches to fragipan
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

En—Ennis gravelly silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: kpd9
Elevation: 900 to 1,300 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ennis and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ennis

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 7 inches: gravelly silt loam
H2 - 7 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Hydric soil rating: No

HaC—Hawthorne gravelly silt loam, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: kpdf
Elevation: 900 to 1,300 feet

Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition
Hawthorne and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawthorne

Setting
Landform: Hillslopes
Landform position (three-dimensional): Crest
Parent material: Gravelly residuum weathered from limestone and siltstone

Typical profile
H1 - 0 to 6 inches: gravelly silt loam
H2 - 6 to 33 inches: very channery silt loam
Cr - 33 to 43 inches: bedrock

Properties and qualities
Slope: 5 to 12 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Hydric soil rating: No

HaD—Hawthorne gravelly silt loam, 12 to 20 percent slopes

Map Unit Setting
National map unit symbol: 2v59f
Elevation: 350 to 1,070 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 57 to 69 degrees F
Frost-free period: 190 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition
Hawthorne and similar soils: 88 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawthorne

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Gravelly residuum weathered from limestone and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: gravelly silt loam
AE - 5 to 12 inches: gravelly silt loam
Bw - 12 to 18 inches: very gravelly silt loam
C - 18 to 26 inches: very gravelly silt loam
Cr - 26 to 36 inches: bedrock

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 30 inches to paralithic bedrock
Natural drainage class: Somewhat excessively drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.10 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Sugargrove

Percent of map unit: 6 percent
Landform: Hillsides
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Dellrose

Percent of map unit: 4 percent
Landform: Hillsides
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear

Hydric soil rating: No

Sengtown

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

HsF—Hawthorne-Sulphura association, steep

Map Unit Setting

National map unit symbol: kpdh
Elevation: 600 to 1,300 feet
Mean annual precipitation: 48 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 185 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Hawthorne and similar soils: 60 percent
Sulphura and similar soils: 20 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawthorne

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Gravelly residuum weathered from limestone and siltstone

Typical profile

H1 - 0 to 6 inches: gravelly silt loam
H2 - 6 to 33 inches: very channery silt loam
Cr - 33 to 43 inches: bedrock

Properties and qualities

Slope: 20 to 60 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Sulphura

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Parent material: Channery residuum weathered from limestone and shale

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 22 inches: very channery silt loam
R - 22 to 32 inches: bedrock

Properties and qualities

Slope: 20 to 60 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Minor components

Percent of map unit: 20 percent
Hydric soil rating: No

HuB—Humphreys gravelly silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: kpdj
Elevation: 600 to 1,200 feet
Mean annual precipitation: 46 to 60 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Humphreys and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Humphreys

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Parent material: Loamy alluvium and/or colluvium derived from limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 51 inches: gravelly silty clay loam
H3 - 51 to 60 inches: gravelly silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 60 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Hydric soil rating: No

MnD2—Minvale gravelly silt loam, 12 to 20 percent slopes, eroded

Map Unit Setting

National map unit symbol: kpdp
Elevation: 500 to 1,200 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 180 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Minvale and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minvale

Setting

Landform: Hillslopes
Landform position (three-dimensional): Base slope

Parent material: Loamy colluvium derived from cherty limestone

Typical profile

H1 - 0 to 8 inches: gravelly silt loam
H2 - 8 to 18 inches: gravelly silt loam
H3 - 18 to 60 inches: gravelly silty clay loam

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

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